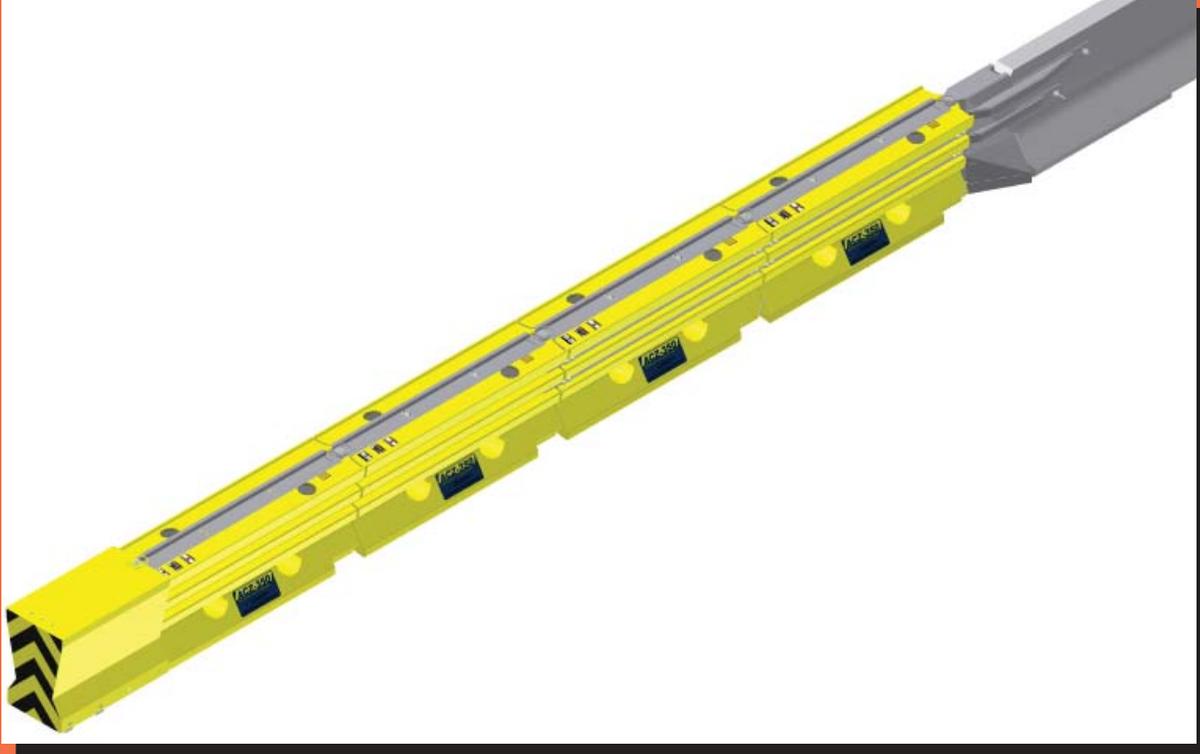
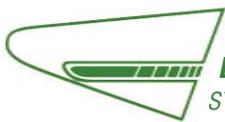


# ACZ-350™ System



*Highly portable, easy to install,  
crashworthy end treatment.*



**ENERGY ABSORPTION  
SYSTEMS, INC.**

*A Quixote Company  
Saving Lives By Design*

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**Installation/Maintenance**

## System Overview

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### Important Introductory Notes

Proper deployment, installation design, and maintenance of the ACZ-350 System is essential to assure maximum performance. Take the time to review this manual 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 ACZ-350, please call Energy Absorption Systems' **Customer Service Department. See the back cover for Contact Information.**

The ACZ-350 System is a highly portable and crashworthy crash cushion, especially suited for use as a temporary barrier in highway construction zones where the chance of high angle, high speed impacts is low.

The ACZ-350 System provides several unique advantages over traditional crash cushions:

- \* No Vaulting
- \* Safely contains errant vehicles within design limits
- \* Quick and easy deployment and retrieval
- \* Protects permanent or temporary, steel or concrete barriers
- \* Lightweight
- \* Economical
- \* Easy cleanup
- \* Narrow profile

The ACZ-350 System is crashworthy and has been thoroughly tested to the National Cooperative Highway Research Program Report 350 (NCHRP 350) testing procedures.

### Function

The ACZ-350 System is designed to perform as a narrow, non-redirecting crash cushion to shield the blunt ends of both permanent and variable length portable concrete median barrier (PCMB), as well as crashworthy steel median barrier systems such as the Vulcan® barrier.

Impacting vehicles are brought to a safe and controlled stop when the System is struck on the nose within design limits. The ACZ-350 System absorbs impact energy and cushions vehicular impacts while significantly reducing the risk to occupants of the impacting vehicle.

**CAUTION: PROPER IMPACT PERFORMANCE WILL ONLY BE ACHIEVED IF ALL SECTIONS ARE PROPERLY POSITIONED. THESE SECTIONS ARE NOT TO BE MIXED WITH SIMILAR SHAPED BARRIER SECTIONS.**

## **Construction**

The ACZ-350 System consists of a sheet metal nose, four (4) water-filled plastic shell segments, and a steel transition pinned together to act as an end treatment. The nose is constructed of light gauge steel and connects directly to the front-most water-filled segment. Each of the four (4) water-filled sections is constructed of a lightweight polyethylene plastic shell designed to accept water ballast. This durable, recyclable material resists cracking, breakage and corrosion under harsh environmental conditions. Each water-filled segment is also equipped with an external, top-mounted steel stiffener which is rigidly fixed to each respective segment. The front two (2) water-filled segments do not contain an internal steel frame or external, side-mounted laminated steel straps. In contrast, the next (or last) two (2) water-filled Barrier segments are equipped with an internal steel frame as well as external side-mounted steel laminated straps. A heavy duty non-crushable steel transition completes the system by connecting the last water-filled segment to the blunt end of the downstream barrier, be it PCMB or Vulcan barrier.

The total length of the TL-3 ACZ-350 System is 9.6 meters (31'-7"). In bi-directional traffic applications, there are no rigid exposed vehicle snag points for traffic traveling from the reverse direction.

The ends of each water-filled section are constructed with knuckles that interlock with those of other segments. The end knuckles are vertically aligned to accept a steel connecting pin. The pin securely joins the sections and the top steel stiffener for maximum impact performance.

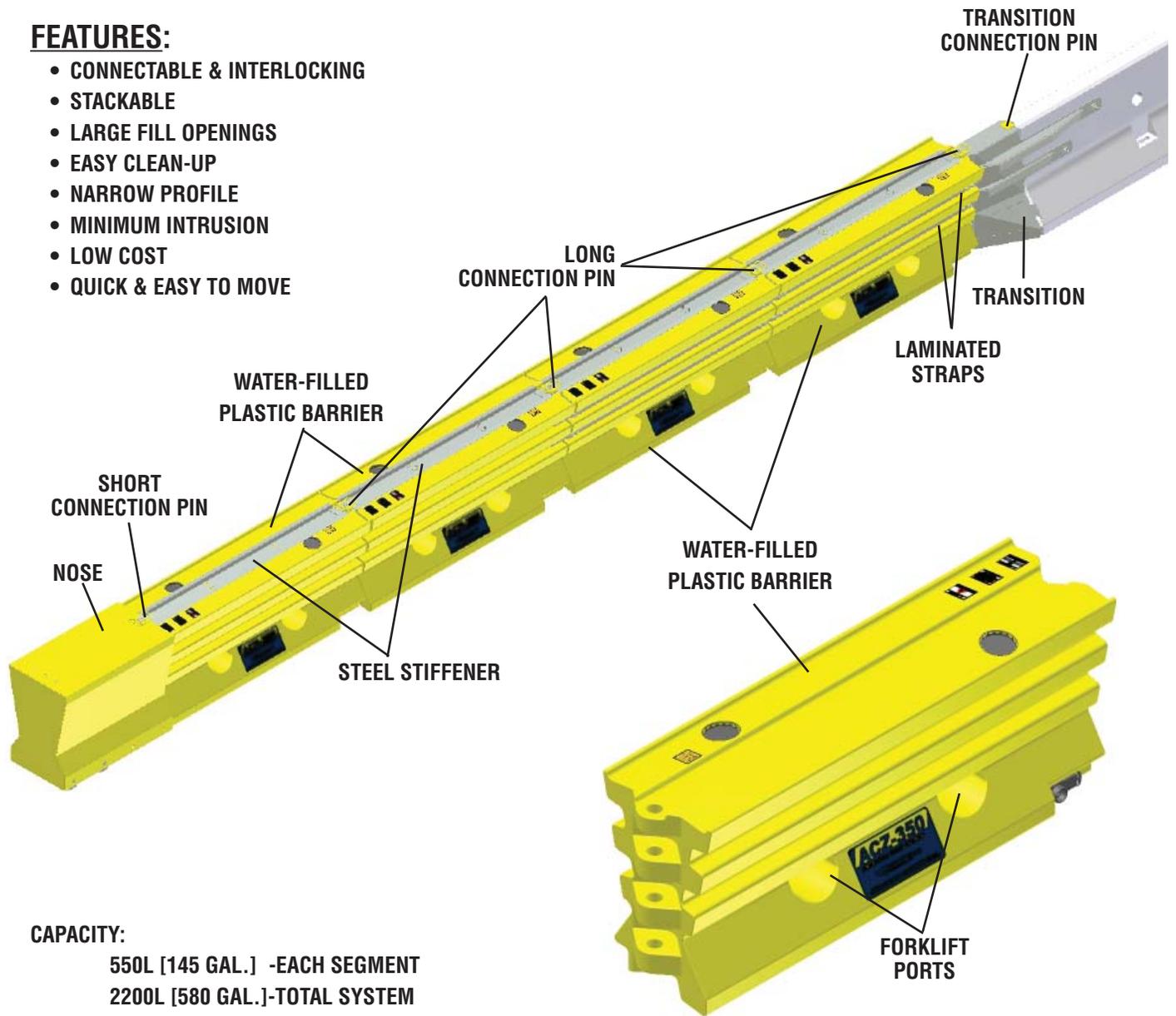
The ACZ-350 water-filled segments are constructed in a unique shape. The inwardly sloping ribbed side walls interact with an impacting vehicle in a way that resists penetration, vaulting, and underriding. Sections are also stackable to reduce shipping and storage space.

Each ACZ-350 segment is constructed with fork lift ports to allow for mechanical lifting if desired. Large fill openings and a rapid release gate valve are provided to allow quick filling or draining of the water ballast. A permanent fill level indicator in the top of each section allows quick verification that the section is adequately full.

# ACZ-350™

## FEATURES:

- CONNECTABLE & INTERLOCKING
- STACKABLE
- LARGE FILL OPENINGS
- EASY CLEAN-UP
- NARROW PROFILE
- MINIMUM INTRUSION
- LOW COST
- QUICK & EASY TO MOVE



## CAPACITY:

550L [145 GAL.] -EACH SEGMENT  
2200L [580 GAL.]-TOTAL SYSTEM

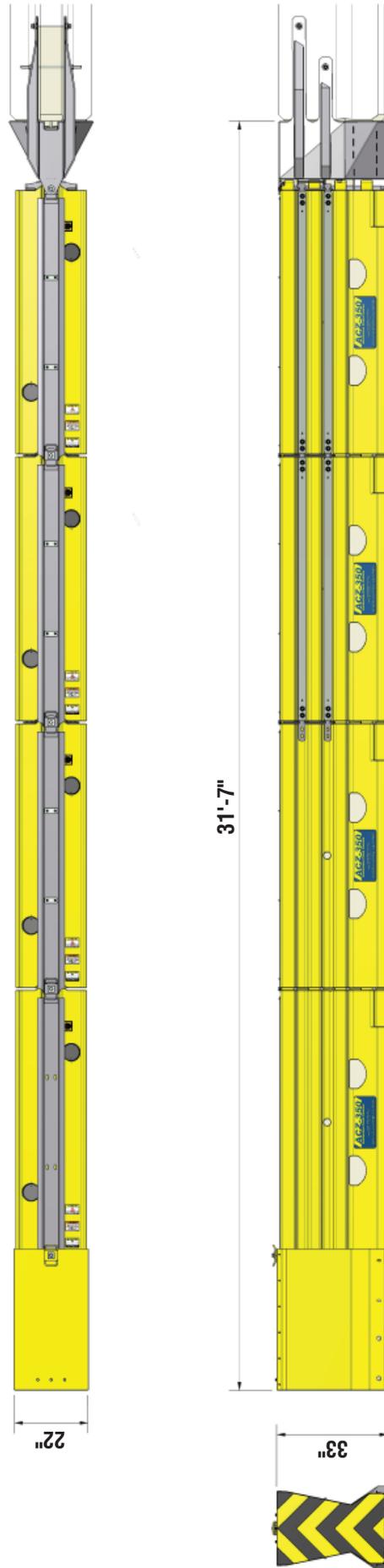
## WEIGHT:

65KG [140 LBS] EMPTY-NO STRAPS -EACH PLASTIC BARRIER  
MAX.156KG [344 LBS] EMPTY-WITH STRAPS -REAR BAY ASSEMBLY  
610KG [1350 LBS] FULL -EACH PLASTIC BARRIER

## COLOR:

ORANGE  
WORK ZONE SAFETY YELLOW

*Figure 1*  
*ACZ-350 Components*



*Figure 2*  
*ACZ-350 Dimensions*

## Conformance

The ACZ-350 System has been tested to and conforms with the current guidelines used by the Federal Highway Administration (FHWA) as recommended in:

*H. E. Ross, D. L. Sicking, H. S. Perera, and J. D. Michie, "Recommended Procedures for the Safety Performance Evaluation of Highway Features", National Cooperative Highway Research Program Report 350, Transportation Research Board, Washington, D.C., 1993*

### End Treatment

End treatment is defined by AASHTO Roadside Design Guide, 1989 as:

"The design modification of a roadside or median barrier at the end".

A terminal is defined by NCHRP 350 as:

"A device designed to treat the end of a longitudinal barrier. A terminal may function by (a) decelerating a vehicle to a safe stop within a relatively short distance, (b) permitting controlled penetration of a vehicle behind the device, (c) containing and redirecting the vehicle, or (d) a combination of a, b and c."

The ACZ-350 System has been crash tested to NCHRP 350 TL-3 Non-Redirective Gating conditions. It has proven to be a crashworthy end terminal for 100 km/h [62 m.p.h.] impact speeds when installed in accordance with the manufacturer's instructions.

Selection, and placement of the ACZ-350 System, and design of installation, should conform to applicable guidelines in:

FHWA, "Manual on Uniform Traffic Control Devices for Streets and Highways" Washington, D.C. 1988.

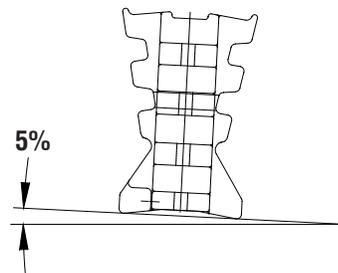
American Association of State Highway and Transportation Officials. "Roadside Design Guide" Washington, D.C.: AASHTO, 1996.

Federal, state, and local criteria governing the ACZ-350 System conformance may vary. Consult local FHWA and State Department of Transportation representatives.

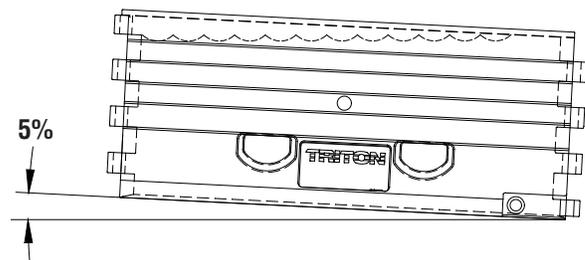
## Special Site Considerations

A traffic control plan, in detail appropriate to the complexity of the work project, should be prepared and understood by all parties before the ACZ-350 System is deployed in a work zone. Some special site considerations are:

1. What is the design speed at the site? The ACZ-350 System is capable of handling impacts from vehicles up to 2000 kg [4400 lb.] at speeds up to 100 km/h [62 m.p.h.] at angles up to 20 degrees.
2. What foundation will the barrier be deployed on and what is its slope? The ACZ-350 System may be deployed on various surfaces. The existence of cross slopes greater than 5%, longitudinal slope greater than 5%, or curbs may create a vaulting effect on the impacting vehicle.



**Figure 3**



**Figure 4**

3. Can the water ballast be drained at the site? If not, provisions must be made to either siphon out the water ballast or use a forklift to move full sections to a location where they can be drained.
4. Will the barrier be used in a climate where the water ballast may freeze? The ACZ-350 System will only perform properly if the water ballast is NOT allowed to freeze. Depending on anticipated climate conditions, an appropriate antifreeze agent may need to be selected and added in appropriate quantities to each water-filled segment to prevent freezing. See Environmental Considerations for available Antifreeze.

## Environmental Considerations

### STORING EMPTY ACZ-350 BARRIER WHEN FREEZING IS EXPECTED

To maintain ACZ-350 BARRIER's portability, it is best not to let water enter the system and freeze. Possible solutions are to cover the sections with a waterproof tarp, leave the gate valves partially open to allow drainage or store the sections upside down being careful not to damage the water level floats.

### **WARNING!**

DO NOT USE THE ACZ-350 BARRIER WHEN THE WATER IN THE BARRIER IS FROZEN OR IF IN DANGER OF FREEZING WITHOUT ANTIFREEZE. USING ACZ-350 BARRIER WHEN FROZEN IS NOT PERMISSIBLE

Water in the ACZ-350 Barriers is critical for proper performance. Special care should be taken to prevent the water from freezing, refer to the "Available Antifreezes" section of this manual for additional information.

## Available Antifreezes

- \* SALT (Sodium Chloride) - 20% solution by weight protects to 0 deg.F. Low cost. Corrosive. Needs to be premixed and large spills may be harmful to vegetation.
- \* CALCIUM CHLORIDE - 35% solution by weight protects to -20 deg F. Medium cost. Corrosive to zinc. Large spills may be harmful to vegetation and spills may be slick. A significant amount of heat is generated during mixing which may require mixing before placing in the barrier.
- \* ETHYLENE GLYCOL - 50% solution by volume protects to -20 deg. F. Medium to high cost. Large spills should be considered dangerous due to potential for environmental harm. Spills may also be slick.
- \* PROPYLENE GLYCOL - 50% solution by volume protects to -20 deg. F. High cost. Large spills may be harmful to vegetation and spills may be slick.
- \* LIQUID CMA (calcium magnesium acetate) - 25% solution by volume protects to 0 deg. F. Very high cost. Considered environmentally safe and nontoxic.
- \* LIQUID POTASSIUM ACETATE - 60% solution by volume protects to -20 deg. F. Extremely high cost. Considered environmentally safe and nontoxic.

### Notes:

1. *The water/antifreeze mixture should be returned to the water truck and recycled for environmental reasons and cost of antifreeze.*
2. *For those mixtures that may be slick, the solution should be washed away with large amounts of water and the area should be sanded to prevent skidding.*
3. *Regardless of which antifreeze is chosen, the user should check local ordinances relating to environmental issues.*
4. *To minimize corrosion of galvanized steel frames, keep segments full of chloride solution. If drained, thoroughly rinse and dry the frames.*

## Installation

### Preparation for Installation

Using the drawings supplied with the System, conduct a parts inventory check to make sure all the necessary components are available before proceeding to the site. Visually check the sections for damage to ensure that they will hold water. Additional sets of installation drawings may be obtained by calling customer service using the appropriate phone numbers located on the back page of this manual.

### Required Tools

For a typical installation the recommended tools and equipment are:

1. ACZ-350 System Installation & Maintenance manual
2. Application and/or traffic control plan (as required)
3. Traffic control equipment (as required)



4. ACZ-350 System components
5. Transport truck
6. Water truck w/pump\*
7. Sledge hammer



8. Pry bar



9. Adjustable wrench



10. 15/16" open end wrench



11. 15/16" socket and ratchet



12. Forklift (optional)



\* A pump with 950-1135 liter/min. [250-300 GPM] output and a 75 mm [3"] dia. minimum x 15-30 m [50-100'] long hose with a shut-off control has been shown to be efficient. Time to fill one barrier is approximately 30 seconds.

# Installation (cont'd.)

1. A flat bed truck with a low bed is ideal for transporting the ACZ-350 System. Secure the load properly before transport.

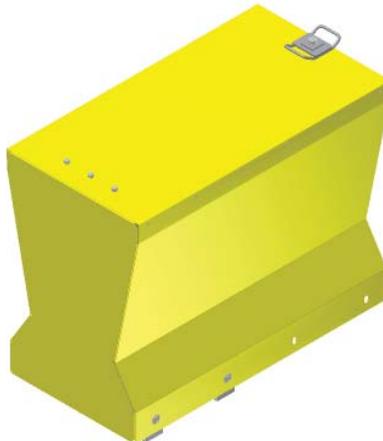
*Note: Each Section Assembly maximum weight: 156 kg [344 lbs.].*

2. Deploy traffic control. A traffic control plan appropriate to the complexity of the project should be prepared and understood by all parties before the ACZ-350 System is installed.

3. Unload the components taking care not to damage them and place in a safe convenient location.



**2795611-0000**  
**TRANSITION**  
**6" PIN & LOOP**  
**(OTHERS AVAILABLE**  
**UPON REQUEST)**



**3595603-0000**  
**NOSE**  
**(STRIPING PATTERNS AVAILABLE**  
**UPON REQUEST)**



**3595605-0000**  
**SHORT PIN**



**3595600-0000**  
**LONG PIN**

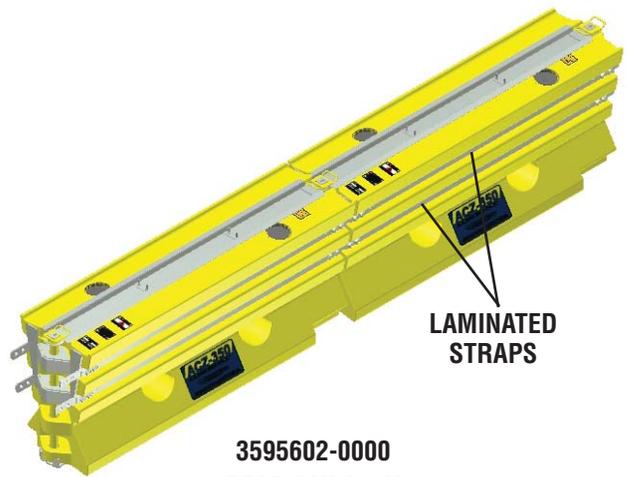


**3595607-0000**  
**TRANSITION PIN**



**3595601-0000**  
**FRONT BAY ASSY**

**NOTE: NO**  
**LAMINATED**  
**STRAPS**



**3595602-0000**  
**REAR BAY ASSY**

**LAMINATED**  
**STRAPS**

*Figure 5*

## Installation (cont'd.)

### Transition Assembly (Pin & Loop\*)

- Slide and pin the Transition around the end of the PCMB or hazard. Verify the two large U-bolts are positioned to cradle the Transition Connection Pin and insert. Evenly tighten the 4 nuts attached to the U-bolt capturing the Transition Connection Pin. Next, use the transition as a template to drill two 7/8" holes through the PCMB. Insert the 3/4" threaded rods and fasten using the supplied nuts and washers. Trim threaded rod after installation to barrier, ensuring rod does not extend more than 3 mm [1/8"] past secured nut. Touch up with cold galvanizing.

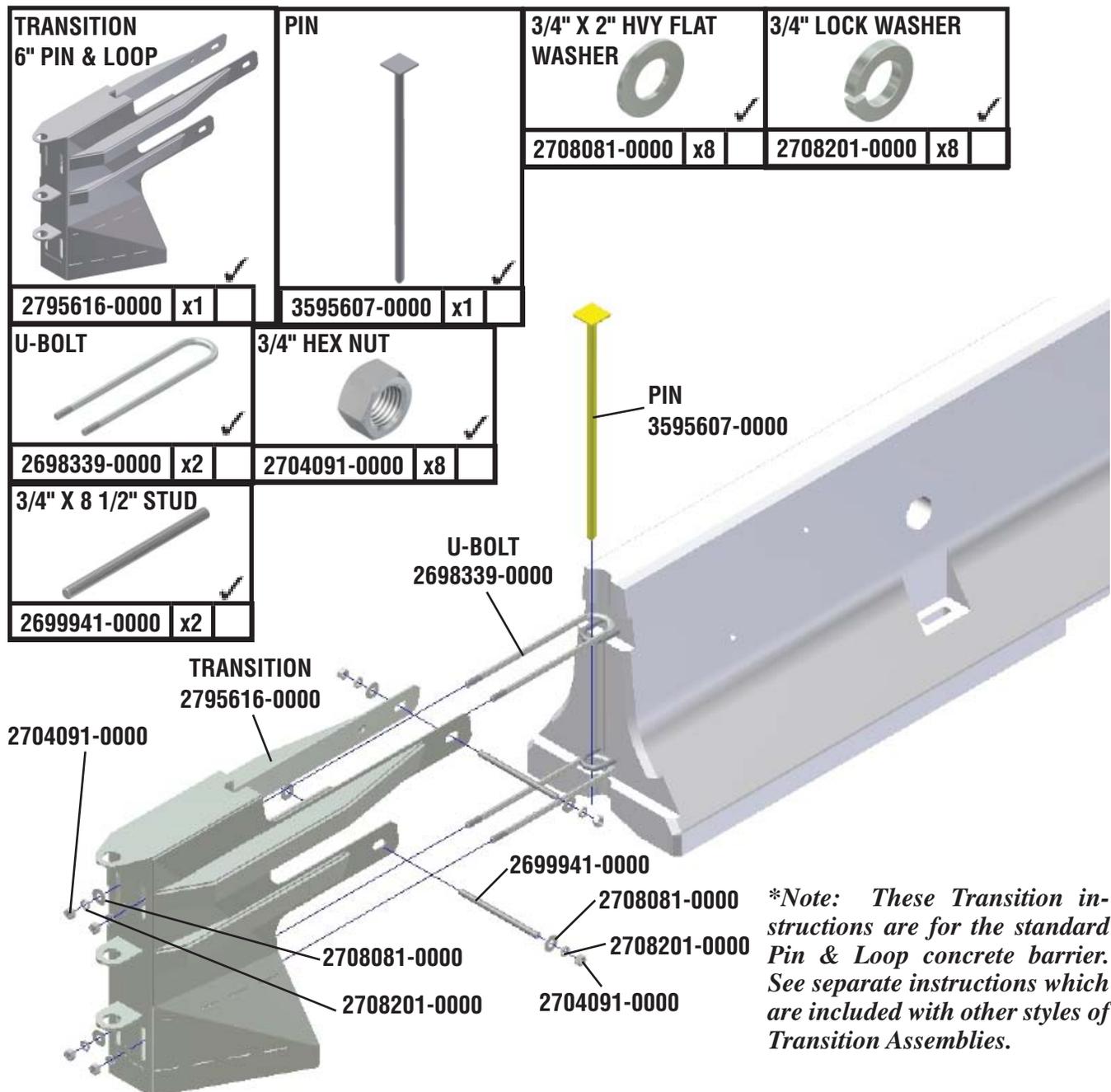
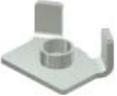
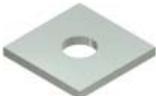


Figure 6

# Installation (cont'd.)

## Rear Bay Assembly

- Align Rear Bay Assembly in front of Transition. Note the orientation of Rear Bay End Knuckles (See Figure 7). Place the Retainer Nut under the Plastic Barrier and insert the Rod assembly through the Transition and Plastic Barrier. Tighten the Rod assembly in the Retainer Nut. Next, insert the Long Connecting Pin through the Plastic Barrier and Transition while guiding the Rod assembly through the center. Attach the Bar Washer on top of the Connecting Pin with the 5/8 bolt and lock washer. Work from the non-traffic side of the installation whenever possible (See Figure 7).

|  |    |   |    |  |    |
|--|----|---|----|--|----|
| <b>REAR BAY ASSEMBLY</b><br>                                       |    | <b>LONG CONNECTING PIN</b><br>             |    | <b>5/8"-11 X 31" THREADED STUD</b><br> |    |
| 3595602-0000   | x1 | 2795605-0000  | x1 | 2698337-0000   | x1 |
| <b>5/8" X 1 1/2" HEX BOLT</b><br> |    | <b>RETAINER NUT</b><br>                  |    | <b>5/8" LOCK WASHER</b><br>                                |    |
| 2701891-0000   | x1 | 2795600-0000  | x1 | 2708231-0000   | x1 |
| <b>5/8" HEX NUT</b><br>                            |    | <b>5/8-11X2 1/8 HEX COUPLING NUT</b><br> |    | <b>3/16X2X2 BAR WASHER</b><br>  |    |
| 2704141-0000   | x1 | 2704851-0000  | x1 | 2795604-0000   | x1 |

## Installation (cont'd.)

### Rear Bay Assembly (cont'd.)

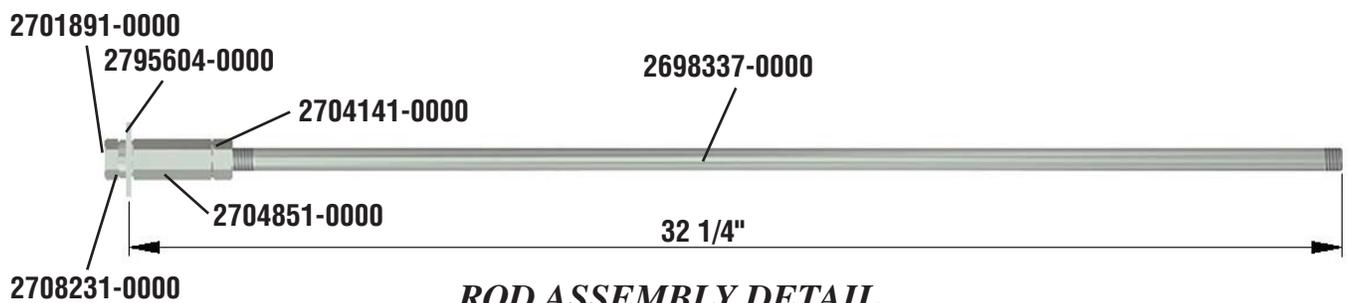
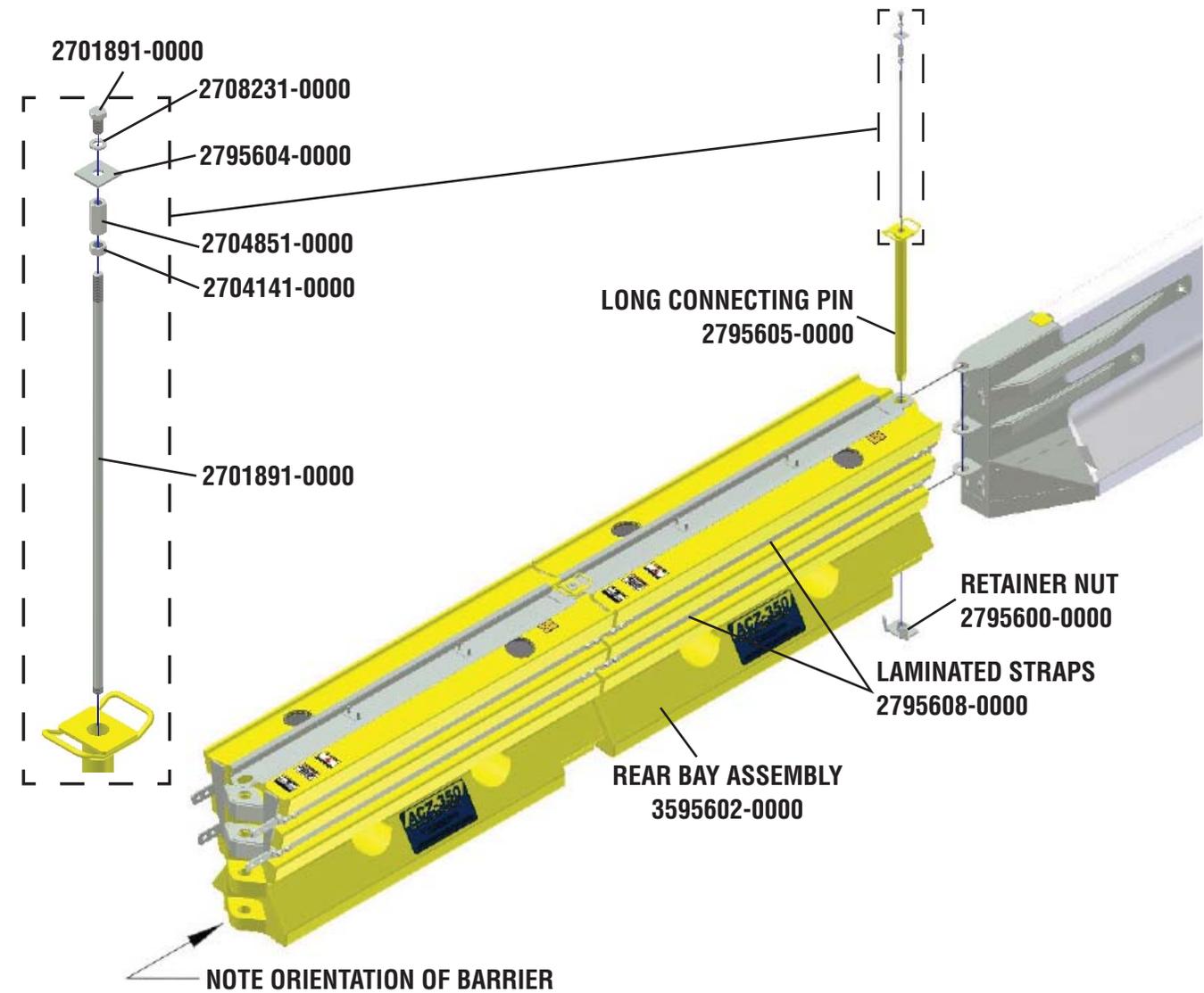
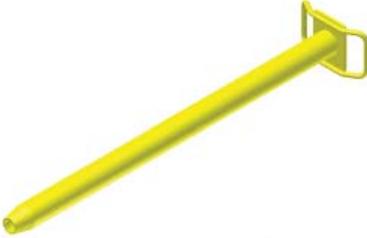
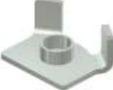
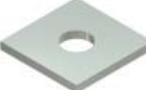


Figure 7

# Installation (cont'd.)

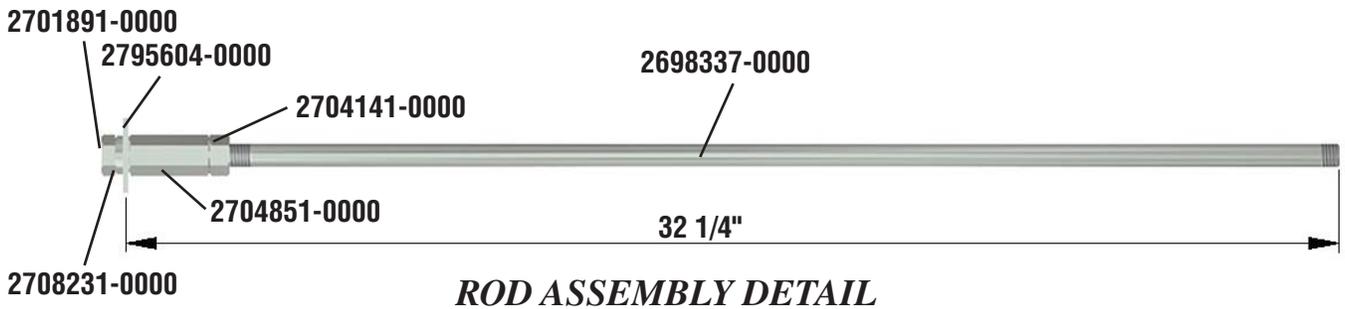
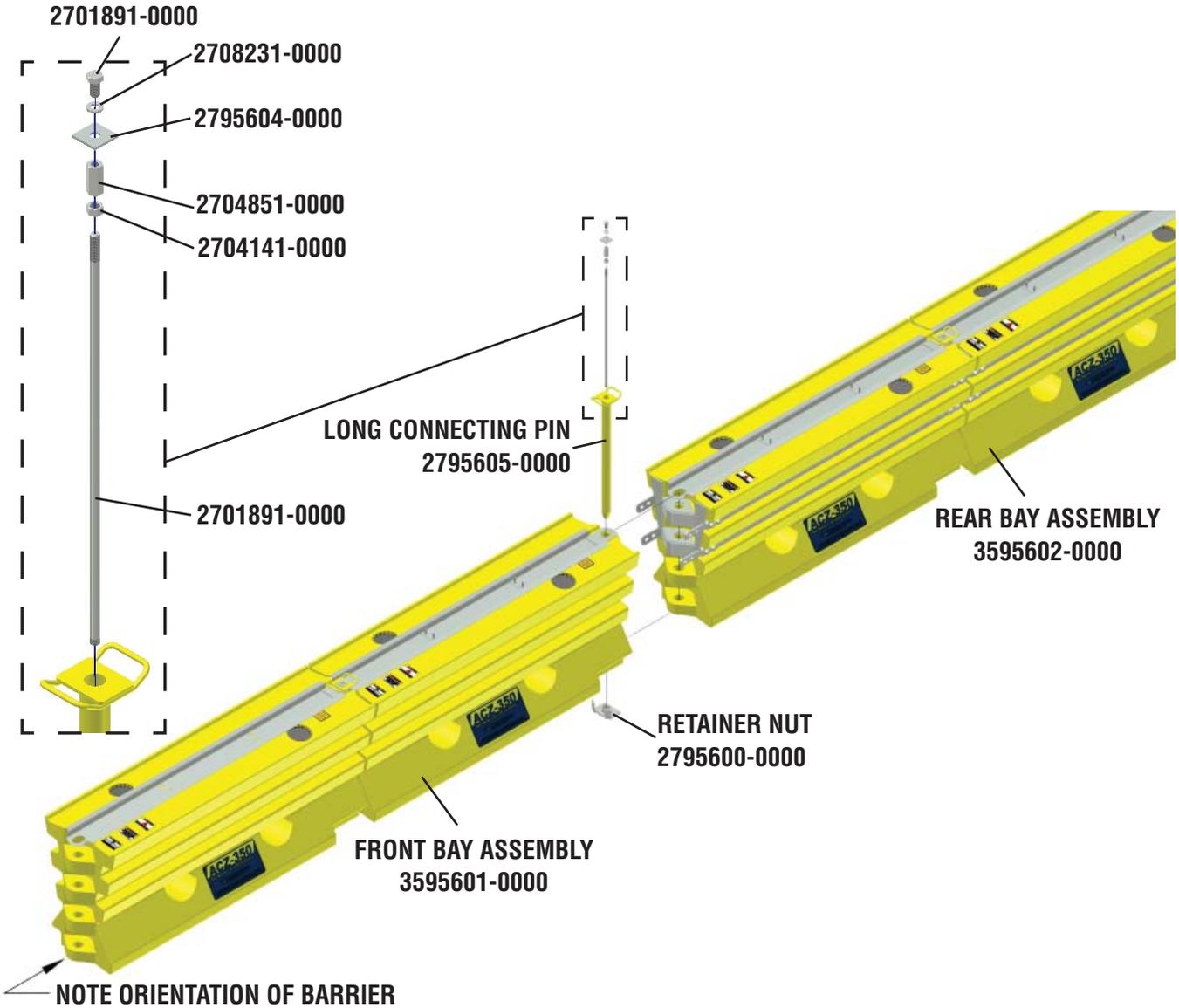
## Front Bay Assembly

- Position Front Bay Assembly in front of Rear Bay Assembly. Note the orientation of End Knuckles (see Figure 8). Place Retainer Nut under the Plastic Barrier. Reposition Front Bay Assembly if necessary, insert the Rod assembly through the two Plastic Barriers and tighten into Retainer Nut. Next, insert the Long Connecting Pin through the two Plastic Barriers while guiding the Rod assembly through the center. Attach the Bar Washer on top of the Connecting Pin with the 5/8 bolt and lock washer.

|  |   |  |   |
|--|---|--|---|
| <p><b>FRONT BAY ASSEMBLY</b></p>                                        | <p><b>LONG CONNECTING PIN</b></p>              | <p><b>5/8"-11 X 31" THREADED STUD</b></p>  |   |
| <p>3595601-0000 x1</p>   | <p>2795605-0000 x1</p>  | <p>2698337-0000 x1</p>   |   |
| <p><b>5/8" X 1 1/2" HEX BOLT</b></p>  | <p><b>RETAINER NUT</b></p>                   | <p><b>5/8" LOCK WASHER</b></p>                                 | <p><b>3/16X2X2 BAR WASHER</b></p>  |
| <p>2701891-0000 x1</p>   | <p>2795600-0000 x1</p>  | <p>2708231-0000 x1</p>   | <p>2795604-0000 x1</p>  |
| <p><b>5/8" HEX NUT</b></p>                             | <p><b>5/8-11X2 1/8 HEX COUPLING NUT</b></p>  |  |   |
| <p>2704141-0000 x1</p>   | <p>2704851-0000 x1</p>  |  |   |

# Installation (cont'd.)

## Front Bay Assembly (cont'd.)

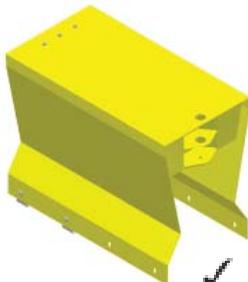
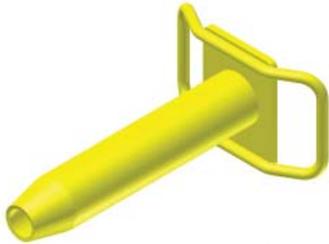
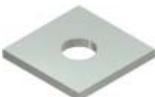


*Figure 8*

# Installation (cont'd.)

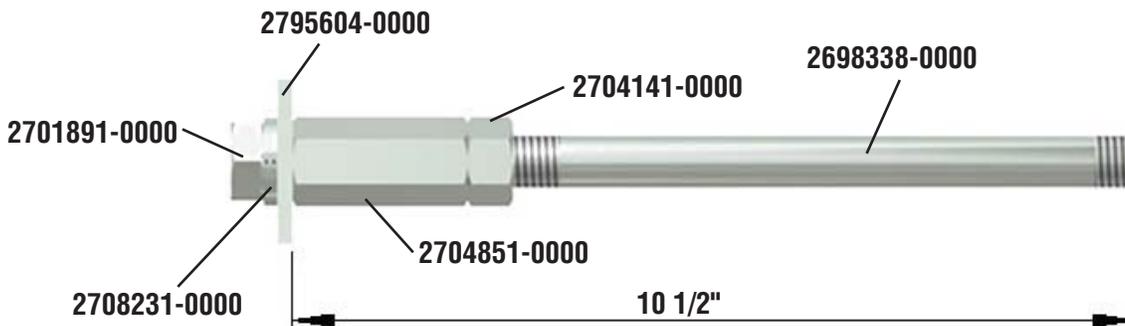
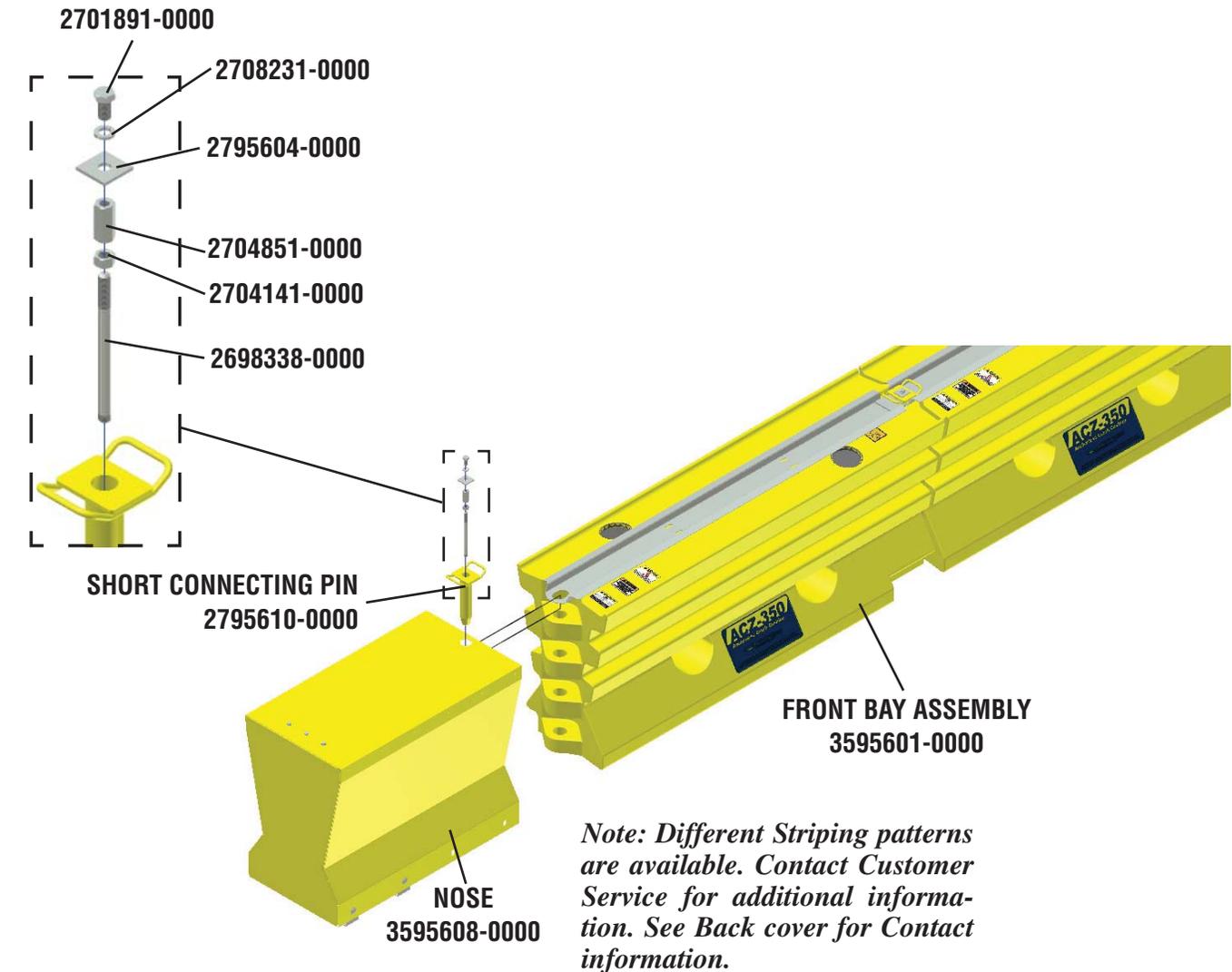
## Nose Assembly

- Position the Nose in front of Front Bay Assembly aligning the connection holes. Insert and tighten the short Rod assembly through the Plastic Barrier and Nose. Next, insert the Short Connecting Pin through the Plastic Barrier and nose while guiding the Rod assembly through the center. Attach the Bar Washer on top of the Connecting Pin with the 5/8 bolt and lock washer (see Figure 9).

|  |  |  |   |
|--|--|--|---|
| <p><b>NOSE</b></p>                      | <p><b>SHORT CONNECTING PIN</b></p>  | <p><b>5/8"-11 X 9" THREADED STUD</b></p>  |   |
| <p>3595608-0000 x1</p>   | <p>2795605-0000 x1</p>   | <p>2698338-0000 x1</p>   |   |
| <p><b>5/8" X 1 1/2" HEX BOLT</b></p>  | <p><b>5/8" LOCK WASHER</b></p>     | <p><b>5/8" HEX NUT</b></p>                | <p><b>5/8-11X2 1/8 HEX COUPLING NUT</b></p>  |
| <p>2701891-0000 x1</p>   | <p>2708231-0000 x1</p>   | <p>2704141-0000 x1</p>   | <p>2704851-0000 x1</p>  |
| <p><b>3/16X2X2 BAR WASHER</b></p>     |  |  |   |
| <p>2795604-0000 x1</p>   |  |  |   |

## Installation (cont'd.)

### Nose Assembly (cont'd.)



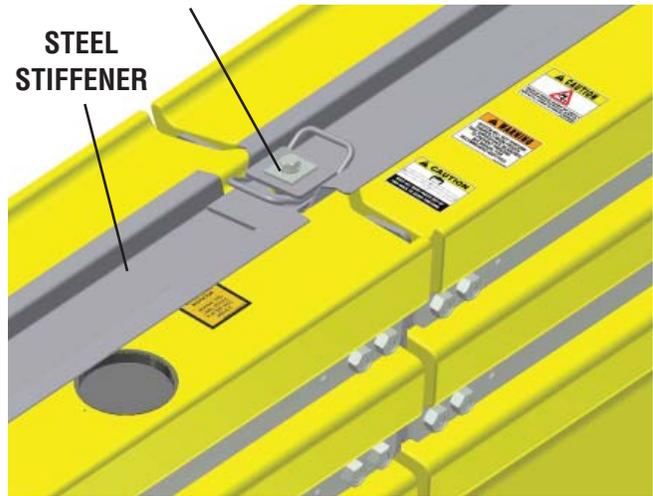
**ROD ASSEMBLY DETAIL**

*Figure 9*

## Installation (cont'd.)

**WARNING!**

Each joint must be connected with a Connection Pin and Secured Rod Assembly or improper impact performance will result. Barrier must not be used if Steel Stiffener is damaged or missing.

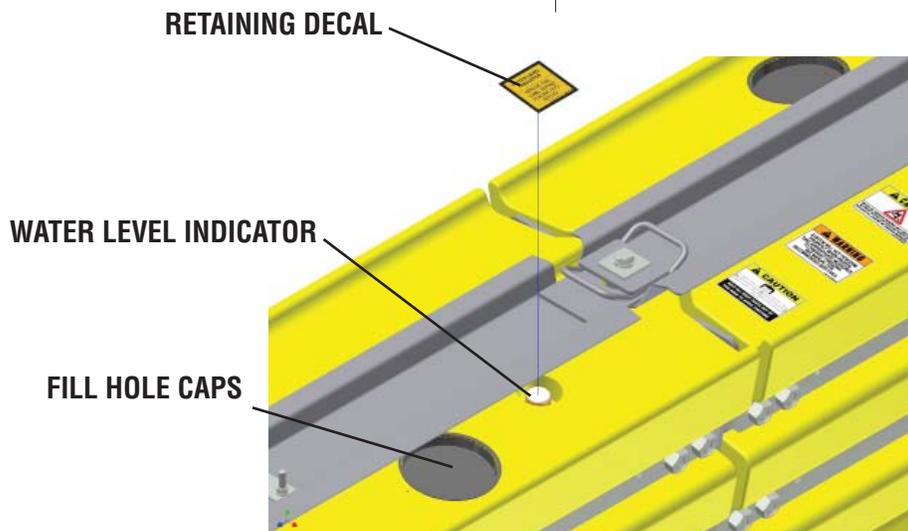
**CONNECTING PIN WITH SECURED ROD ASSEMBLY***Figure 10*

- Remove the Water Level Indicator Retaining Decal with a small flat screw driver.

**RETAINING DECAL**

REMOVE BEFORE FILLING BARRIER WITH WATER.

IF THE WATER LEVEL INDICATOR IS DAMAGED, REACH INSIDE THE BARRIER, REMOVE THE DAMAGED INDICATOR AND REPLACE WITH A NEW ONE.

*Figure 11*

## Installation (cont'd.)

9. Remove the Fill Hole Cap and completely fill all four Plastic Barrier segments with water. Approximately 2200 liters (580 gallons) will be required.

### **WARNING!**

DO NOT USE THE ACZ-350 BARRIER WHEN THE WATER IN THE BARRIER IS FROZEN OR IF IN DANGER OF FREEZING WITHOUT ANTIFREEZE. USING ACZ-350 BARRIER WHEN FROZEN IS NOT PERMISSIBLE. Water in the ACZ-350 Barriers is critical for proper performance. Special care should be taken to prevent the water from freezing, refer to the "Available Antifreezes" section of this manual for additional information.

The water truck can follow immediately behind the deployment crew to minimize time in the work zone. Filling proceeds more quickly if one worker drives the water truck and another moves the fill hose from section to section.

10. Place caps in fill holes to retard water evaporation and to prevent debris, bugs and birds from contaminating the water.
11. Deployment is now complete. Take the time to double check the installation.

### **WARNING!**

All plastic barriers must be filled with water to ensure proper crash performance.

### **WARNING!**

Water on traveled roadways may create a slippery surface for vehicles. Repair or replace all leaking or damaged barriers.

## Checking the Installation

Check the installation to ensure that all sections are properly aligned, full of water ballast, and not leaking. All fill level indicators should be up. If any are not up, check to see if the Retaining Decals for shipment are still in place, and remove them. Make sure that all steel stiffeners and side straps are present and all pins are securely inserted. If for some reason a section needs replacement, refer to the "Maintenance and Repair" section of this manual.

## Retrieval

1. Begin retrieval at the nose end of the System. Begin the retrieval procedure by removing the water ballast. If site conditions permit, the quick release gate valve may be opened to allow the water to drain.

*Note: The time it takes to drain a barrier section is approximately 4.5 minutes.*

**Caution: Water on traveled roadways may create a slippery surface for vehicles. Proper traffic control should be deployed.**

If the water can not be drained at the site, then the water may either be siphoned out or each water-filled section can be unpinned, disassembled, and moved by forklift to another work area or a site where it may be drained or stored.

**Caution: Do not lift more than one (1) filled barrier at any given time.**

**Caution: Do not use steel stiffener to lift barrier. Use fork lift and lift ports.**

2. Remove the pins and separate the sections.
3. Remove the sections onto the transport truck in the reverse order as they were deployed. Secure the load before transport.

## Storing

When storing the ACZ-350 System, be sure to leave the gate valve open or store upside down.

*Note: Empty sections may be stacked up to three high. Filled sections may not be stacked.*

# Maintenance and Repair

## Visual Drive-By Inspection

A slow drive-by visual inspection of the ACZ-350 System is often all that is required. Some special inspection considerations are:

1. Are the four sections full of water ballast? The sections must be adequately filled for proper impact performance. Look to see that the fill level indicators are visible above the top of each section. A walk-up inspection of the installation is required if the fill indicators are not visible (see Walk-Up Inspection section). Be sure fill indicator Retaining Decals used for shipping have been removed.
2. Are the sections properly aligned? The installation must be aligned according to the plans for the site. Misaligned sections in the middle of an installation may be an indication that the barrier has been hit and potentially damaged. If any sections are misaligned, carry out a walk-up inspection.
3. Is there fluid on the ground? The sections must be adequately filled for proper impact performance. Leaking sections in the middle of an installation may be an indication that the barrier has been hit and potentially damaged. A walk-up inspection of the installation is required if fluid is present in the surrounding area.

## Walk-up Inspection

If the drive-by visual inspection indicates maintenance is required, then a walk-up inspection is necessary. Some of the most common maintenance concerns and corresponding repair techniques are:

### Empty Sections

Sections with water levels below 100 mm [4"] from the top must be refilled for proper ACZ-350 System performance. Sections with very low water levels, or those that consistently need filling, should be filled and thoroughly inspected for leaks. If leaks are found, the section should

be replaced or repaired (see Damaged Sections below). A certain amount of water loss may occur due to evaporation depending on the environment. Also see "ACZ-350 Barrier Patching Preparation" on following page.

## Damaged Sections

Generally sections are usable if they remain full of water and properly connected to other sections. Occasionally, sections may become damaged from impact or puncture and must be replaced. Sections with minor damage or leaks may often be repaired using sealants or plastic welding methods. (See ACZ-350 BARRIER Patching.) Empty the water from the sections immediately surrounding the damaged section(s). Remove the pins and other attaching hardware of the damaged section(s) and slide the section(s) sideways until enough gap opens up in the installation for removal. New sections are replaced by reversing this process. Take care to work in a direction away from traffic and to properly line up the installation when replacement is complete (see Misaligned Sections).

## Misaligned Sections

Sections may occasionally become misaligned due to impact or nuisance hits. Generally 600-900 mm [2 to 3'] of lateral misalignment is easily corrected by simply pushing the sections back into alignment. If the sections are emptied, they can usually be pushed manually; if they are full, they can be nudged into position with a vehicle, pry bar, or forklift, being sure to use the forklift ports when appropriate. Care must be taken to avoid damaging the sections.

## To Remove Pin

1. Remove 5/8 bolt, washer, and rod hardware.
2. Pry pin up while pushing steel stiffener down.
3. Once pin is up approximately 100 to 125 mm [4" to 5"], the pin can be twisted to remove.

## Maintenance and Repair (cont'd.)

Proper maintenance of the ACZ-350 System is essential to assure maximum performance. Take the time to review the product limitations, installation cautions, and maintenance instructions before performing the necessary work. Do not attempt to install any crash cushion without the proper plans for the installation.

The time interval between maintenance inspections depends a great deal upon particular site conditions. Frequent inspections are recommended until a longer inspection interval becomes justified.

### ACZ-350 BARRIER Patching Preparation:

The area to be patched must be completely dry and free of dirt and grease. Additionally, a film coats the barrier and should be removed by either lightly sanding the pieces or burning it off with a small butane torch. Do not damage the plastic by overheating. A few quick passes are sufficient.

### Options:

#### Plastic Welding

The most reliable means of patching can be accomplished with plastic welding and can range from "stick" welding to automatic preparation and feed. The temperature, as measured 6 mm [1/4"] away from the welding torch should be at 290 deg. C [550 deg. F.] for the ACZ-350 material. Welding speed for ideal, straight line welds can range from 100 mm - 150 mm [4" to 6"] per minute with stick welding to 600 mm [24"] per minute with an automatic gun. A plastic welding equipment supplier can offer additional information.

#### Spin Weld Plugs

Spin Weld plugs give excellent results for patching small holes and leaks in Barriers. Individuals who will be performing the repairs should read the instructions and practice a few times before trying to repair ACZ-350 BARRIER. Practicing the Spin Weld process is important as this gives the individual a feel for the techniques required to perform a proper weld.

### Items necessary for repair:

- Drill Motor w/7 mm drill bit
- 25,000 rpm Router
- Spin Weld tool
- Spin Weld plugs
- Rasp

1. Drill 7 mm hole at point of leak.
2. Secure the Spin Weld tool into Router.
3. Place a Spin Weld plug onto the Spin Weld tool.
4. Place plug and router squarely over the hole to be plugged.
5. Turn on the router, holding it firmly with light downward pressure. Watch for indications of melting plastic flowing around the plug. Turn off the router, holding it steady until the plastic solidifies.
6. Inspect plug to insure that it has bonded to the barrier.
7. Rasp plugged area smooth to finish repair.

### Hot Glue Gun

Relatively good success in patching the ACZ-350 BARRIER can be accomplished with a standard hot glue gun using general purpose adhesive. This type of patching will deteriorate over an extended period of exposure to the sun and other environmental conditions. The best results will be obtained by using patience and large amounts of glue.

### Field Patching

Initial preparation as outlined above should be accomplished whenever feasible. No materials are available that adhere properly when applied to a wet barrier. Duct tape (silver, fiber reinforced tape) sticks to the barrier well, and Butyl caulking (gray, sticky pads or rolls) works

# Maintenance and Repair (cont'd)

fairly well to fill gaps for temporary patching. The blue and yellow ACZ-350 BARRIER decals stick well to the barriers. Spare decals can be kept on hand and cut to size with scissors for effective temporary patch. The decal will need to be placed smoothly without air pockets or creases to obtain the best results. Smaller holes on smooth faces will seal while larger gashes can be reduced to minor trickles. Should the decal begin to leak, it will deteriorate rapidly.

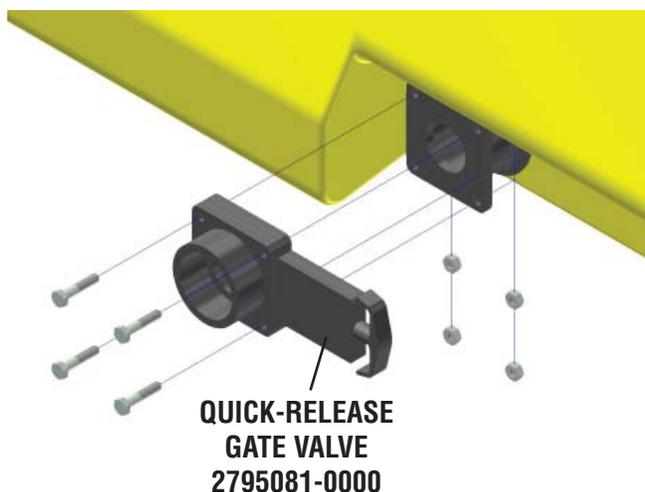
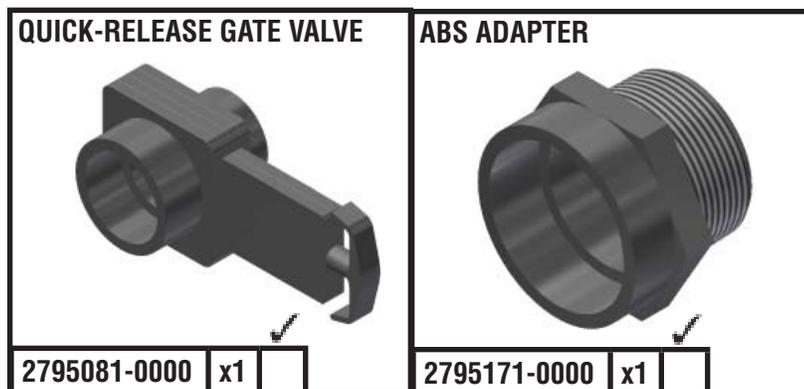
Both fiberglass resin or epoxy can be used to fill and plug leaks. Epoxy's liquid consistency makes it more difficult to keep in any hole during its cure, but is effective if this shortfall can be overcome. Fiberglass resin and

sheeting/cloth can be used on larger areas. The exterior of the matte must be completely covered with resin. Otherwise, any exposed fibers will quickly act like wicks and the patch will fail. The resin or epoxy will require a curing time before the barrier may be refilled with water.

Any repaired barriers should be marked for easy identification. It is recommended to periodically check the repairs for leaks.

## Gate Valves and Plugs

Gate valves must be unbolted before adapters can be unscrewed. Six or seven wraps of Teflon tape will keep the threads from leaking.



*Figure 12*



*Figure 13*

## Maintenance and Repair (cont'd)

### Post Impact Review

*Note: Only the correct parts manufactured by Energy Absorption Systems, Inc. should be used to repair a damaged system. Failure to comply could result in reduced safety or damage to the system.*

#### 1. *Inspect each barrier for defects.*

Replace any barrier that is deformed or unable to hold water. Do not attempt to straighten or reshape. Attempts to do so may further damage the barrier or change the energy absorbing characteristics. Replacement of damaged barrier is critical to the performance of the system. Failure to do so may lead to unacceptable results.

#### 2. *Inspect all steel straps, pins and stiffeners.*

Replace any steel component that is deformed. Do not attempt to weld, straighten, or reshape. Attempts to do so may further damage the steel components or change the energy absorbing characteristics. Replacement of damaged steel components is critical to the performance of the system. Failure to do so may lead to unacceptable results.

#### 3. *Inspect the Nose for damage.*

Replace the Nose if deformed. Do not attempt to straighten or reshape. Attempts to do so may further damage the Nose or change the energy absorbing characteristics. Replacement of damaged Nose is critical to the performance of the system. Failure to do so may lead to unacceptable results.

#### 4. *Inspect the transition for damage.*

Although unlikely, the transition could be damaged during impact. Replace the transition if deformed. Do not attempt to straighten or reshape. Attempts to do so may further damage the transition or change the performance characteristics. Replacement of

damaged Transition is critical to the performance of the system. Failure to do so may lead to unacceptable results.

#### 5. *Inspect the attaching concrete or steel barrier.*

Replace the attaching barrier if deformed or cracked. Do not attempt to straighten, reshape or patch. Attempts to do so may further damage the barrier or change the energy absorbing characteristics. Replacement of damaged concrete or steel barrier is critical to the performance of the system. Failure to do so may lead to unacceptable results.

Items that might need replacement after an impact are as follows:

- Nose assembly (striping patterns available upon request)  
3595608-0000
- Front Bay Assembly  
3595601-0000
- Rear Bay Assembly  
3595602-0000
- Strap assembly  
2795608-0000
- Top stiffener  
2795601-0000
- Plastic Barrier with frame  
3595534-0300
- Plastic Barrier without frame  
3595535-0300
- Long connecting pin assembly  
3595600-0000
- Short connection pin assembly  
3595605-0000

# Glossary

**Barrier**-A device that provides a physical limitation through which a vehicle would not normally pass. It is intended to contain or redirect an errant vehicle. (A)

**Bidirectional**-A traffic direction in relation to the hazard which is one direction on one side of the hazard and the opposite direction on the other side. (E)

**Capacity**-The ability of an appurtenance to absorb the kinetic energy of an impacting vehicle in a safe and controlled manner. (E)

**Clearance**-Lateral distance from edge of traveled way to a roadside object or feature. (A)

**Clear Zone**-The total roadside border area, starting at the edge of the traveled way, available for safe use by errant vehicles. This area may consist of a shoulder, a recoverable slope, a nonrecoverable slope, and/or a clear run-out area. The desired width is dependent upon the traffic volumes and speeds, and on the roadside geometry. (A/N)

**Construction Zone**-A highway area under construction or refurbishment with traffic concerns. (E)

**Crash Tests**-Vehicular impact tests by which the structural and safety performance of roadside barriers and other appurtenances may be determined. Three evaluation criteria are considered, namely (1) structural adequacy, (2) occupant risk, and (3) vehicle trajectory. (A)

**Crashworthy**-A feature that has been proven acceptable for use under specified conditions either through crash testing or in-service performance. (A)

**Critical Impact Point (CIP)** - That point along a device with the greatest potential for snagging or pocketing an impacting vehicle. (E)

**Design Speed**-The speed selected and used for correlation of the physical features of a highway that influence vehicle operation. It is the maximum safe speed that can be maintained over a specified section of highway when conditions are so favorable that the design features of the highway govern. (A)

**End Treatment**-The designed modification of a roadside or median barrier at the end. (A)

**Flare**-The variable offset distance of a barrier to move it further from the traveled way. (A)

**Gating Device (Feature)** - A device designed to allow controlled penetration of a vehicle when impacted upstream of the beginning of the length of need (LON). Note that some distance is present between the end of a gating device and the beginning of the LON of the device. (N)

**Glare Screen**-A device used to shield a driver's eye from the headlights of an oncoming vehicle. (A)

**Hazard**-Something dangerous and obstructive in the median, roadway, or roadside. (E)

**Impact Angle**-For a longitudinal barrier, it is the angle between a tangent to the face of the barrier and a tangent to the vehicle's path at impact. (A)

**Lateral Deflection**-The distance an appurtenance is deflected sideways from its original position. (E)

**Length of Need (LON) - Total** length of a longitudinal barrier needed to shield an area of concern. (A)

**Longitudinal Barrier**-A barrier whose primary function is to prevent penetration and to safely redirect an errant vehicle away from a roadside or median hazard. (A)

**Median**-The portion of a divided highway separating the traveled ways for traffic in opposite directions. (A)

**Median Barrier** - A longitudinal barrier used to prevent an errant vehicle from crossing the highway median. (A)

**Non-Gating Device** - A device with redirection capabilities along its entire length. Note that the end of a non-gating device is the beginning of the length of need for the device. (N)

**Offset** - The distance between the traveled way and a roadside barrier or other obstacle. (A)

**Penetration** - Action of a vehicle passing into or through an appurtenance by overcoming its redirective resistance. (E)

**Performance Level** - The degree to which a longitudinal barrier is designed for containment and redirection of different types of vehicles and speeds. (A)

**Redirective** - A characteristic of an appurtenance that

## Glossary (cont'd.)

indicates that the device smoothly controls a vehicle angle impact without pocketing or penetration. (E)

**Roadside** - That area between the outside shoulder edge and the right-of-way limits. (A)

**Roadside Barrier** - A longitudinal barrier used to shield roadside obstacles or non-traversable terrain features. It may occasionally be used to protect pedestrians or "bystanders" from vehicle traffic. (A)

**Roadway** - The portion of a highway, including shoulders, for vehicular use. (A)

**Secondary Impact**-Vehicle impact(s) subsequent to vehicle loss of contact with an appurtenance. (E)

**Shielding**-The introduction of a barrier or crash cushion, between the vehicle and an obstacle or area of concern to reduce the severity of impacts of errant vehicles. (A)

**Slope**-The relative steepness of the terrain expressed as a ratio or percentage. Slopes may be positive (back slopes) or negative (fore slopes), and as parallel or cross slopes in relation to the direction of traffic. (A)

**Temporary Barrier**-A device used to prevent vehicular access into construction or maintenance work zones and to redirect an impacting vehicle so as to minimize damage to the vehicle and injury to the occupants, while providing worker protection. (A)

**Terminal**-A device designed to treat the end of a longitudinal barrier. A terminal may function by (a) decelerating a vehicle to a safe stop within a relatively short distance, (b) permitting controlled penetration of a vehicle behind the device, (c) containing and redirecting the vehicle, or (d) a combination of a ,b and c. (N)

**Test Level**-A set of impact conditions, defined in terms of vehicular type, mass, speed, and angle, that quantifies the performance level of a traffic barrier. (N)

**Traffic Barrier**-A device used to prevent a vehicle from striking a more severe obstacle or feature located on the roadside or in the median, to prevent crossover median

accidents, or to provide worker protection. (A)

**Transition**-That part of a longitudinal barrier between and connecting sections of differing lateral stiffness. (N)

**Traveled Way**-That portion of the roadway for the movement of vehicles, exclusive of shoulders and auxiliary lanes. (A)

**Underriding**-Abrupt movement of an impacting vehicle down and underneath an appurtenance. (E)

**Vaulting**-Abrupt movement of an impacting vehicle up and over an appurtenance. (E)

**Vehicle**-As used herein an automobile used in transporting passengers ranging in weight and styles from 820 to 2000 kg [1800 to 4415 lb.]. (E)

**Warrants**-The criteria by which the need for a safety treatment or improvement can be determined. (A)

References:

- (A) American Association of State Highway and Transportation Officials. "1989 Roadside Design Guide" Washington D.C.).
- (E) Energy Absorption Systems, Inc., "Safety Needs Analysis Program (SNAP)" Chicago, IL: Energy 1992.
- (N) National Cooperative Highway Research Program Report 350 (NCHRP 350).
- (T) Lewis, R. M., "Work Zone Traffic Control Concepts and Terminology," *Transportation Research Record*, No. 1230, Transportation Research Board, 1989, pp. 1-11.

# Limitations and Warnings

The ACZ-350 System has been successfully tested and evaluated per the NCHRP 350 guidelines (NCHRP 350) for Test Level 3 (TL-3) End Treatment. The selected test matrix impact conditions recommended in this guideline are intended to encompass the majority, but not all, of the possible in-service collisions.

Properly deployed, the ACZ-350 System (see Installation and Retrieval section of this manual) is capable of dissipating the kinetic energy of errant vehicles:

**Vehicles:**

Small car, large sedan and pickup

**Speed:**

TL-3 100 km/h [62 m.p.h.]

TL-2 70 km/h [45 m.p.h.]

**Mass:**

820 and 2000 kg

[1808 and 4409 lb]

**Angle:**

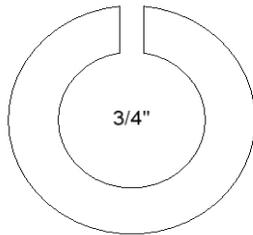
The ACZ-350 System is a non-redirective crash cushion. It is recommended that the ACZ-350 System be used to protect concrete/steel barrier at sites where the chance of high angle, high speed impacts is low. When these types of angled impacts may occur, a redirective crash cushion, such as the QuadGuard® System, should be installed instead.

Impacts that exceed the performance level of the product may not result in acceptable crash performance as described in NCHRP 350 relative to structural adequacy, occupant risk, and vehicle trajectory evaluation factors.

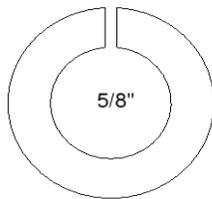
Proper maintenance of the ACZ-350 System is essential to assure maximum performance (see the Maintenance and Repair section of this manual).

# ACZ-350™

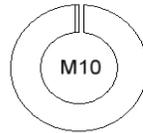
## Fastener Reference Chart



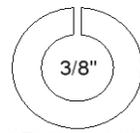
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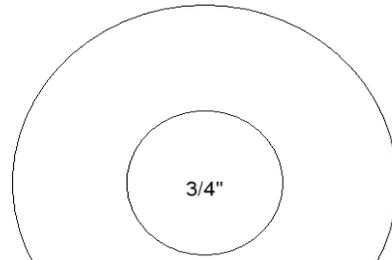
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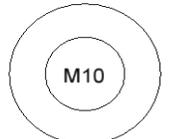
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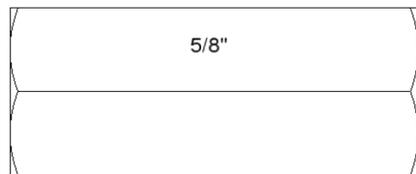
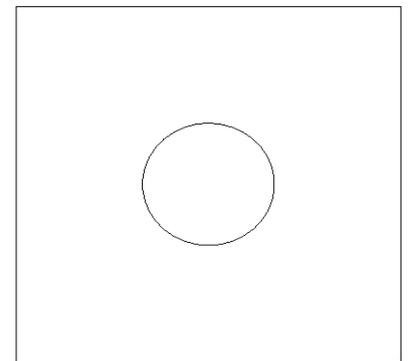
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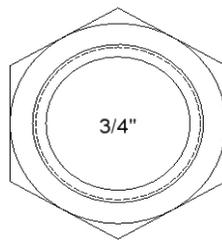
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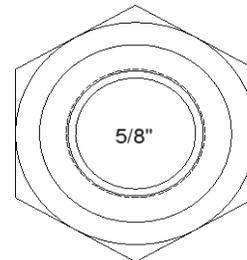
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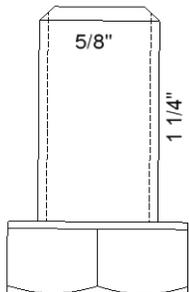
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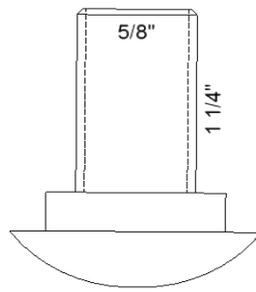
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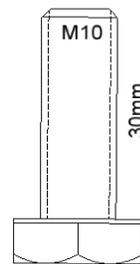
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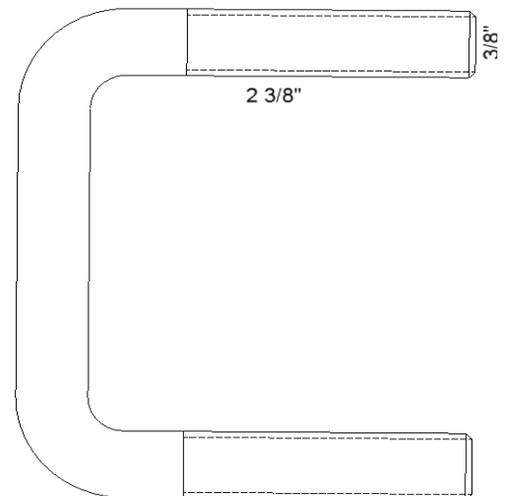
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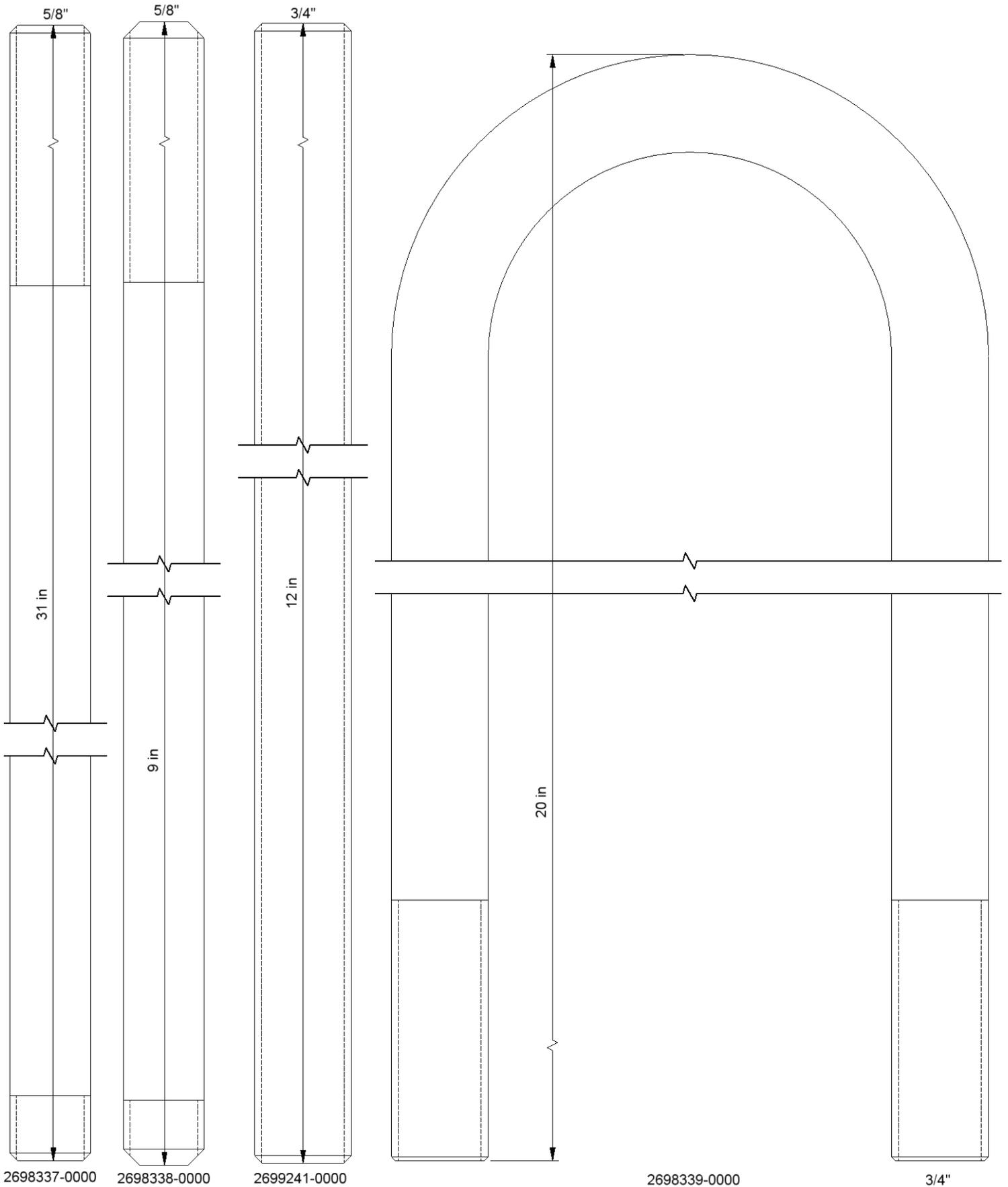


2698323-0000



2698336-0000

## Fastener Reference Chart



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**ENERGY ABSORPTION  
SYSTEMS, INC.**

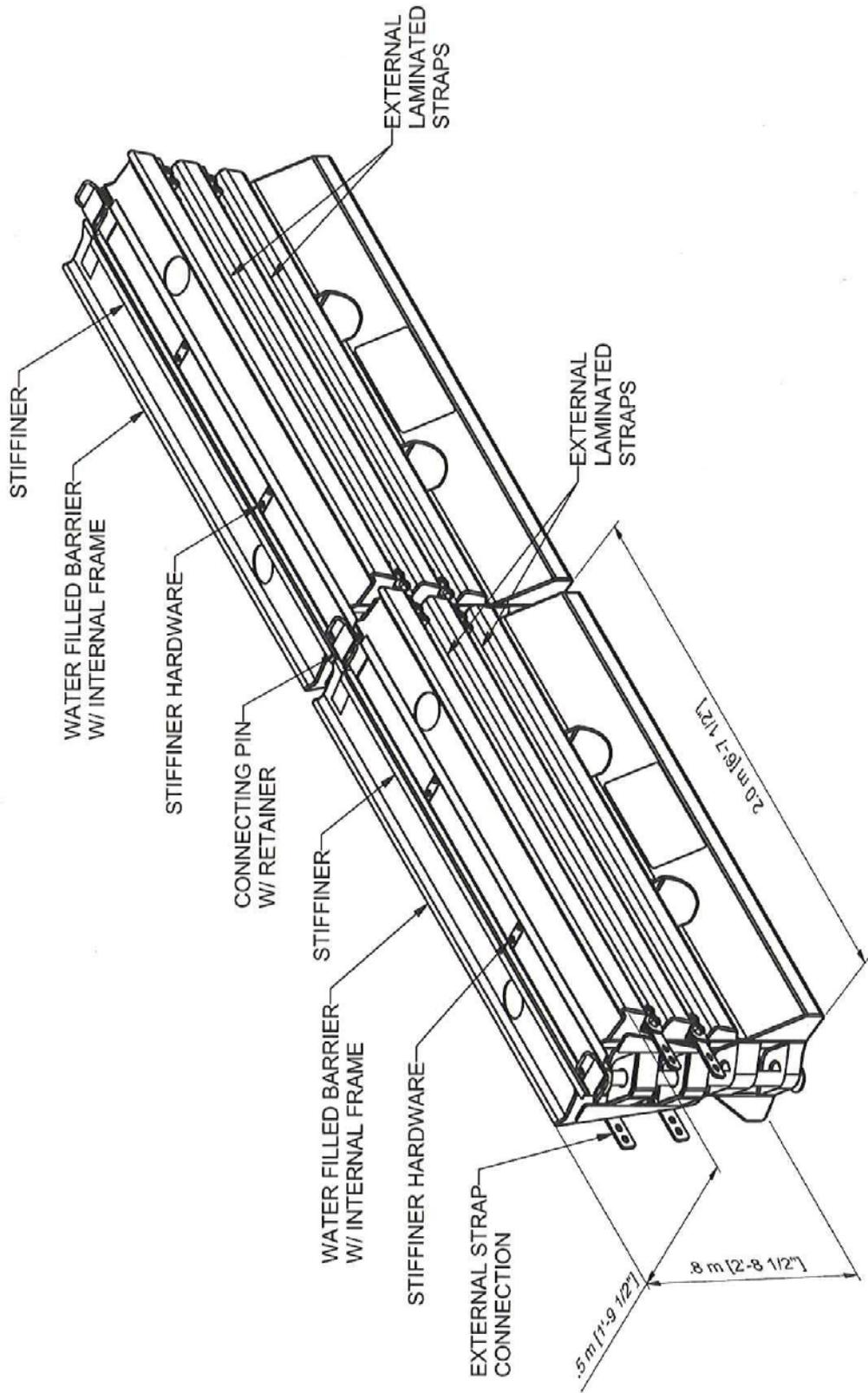
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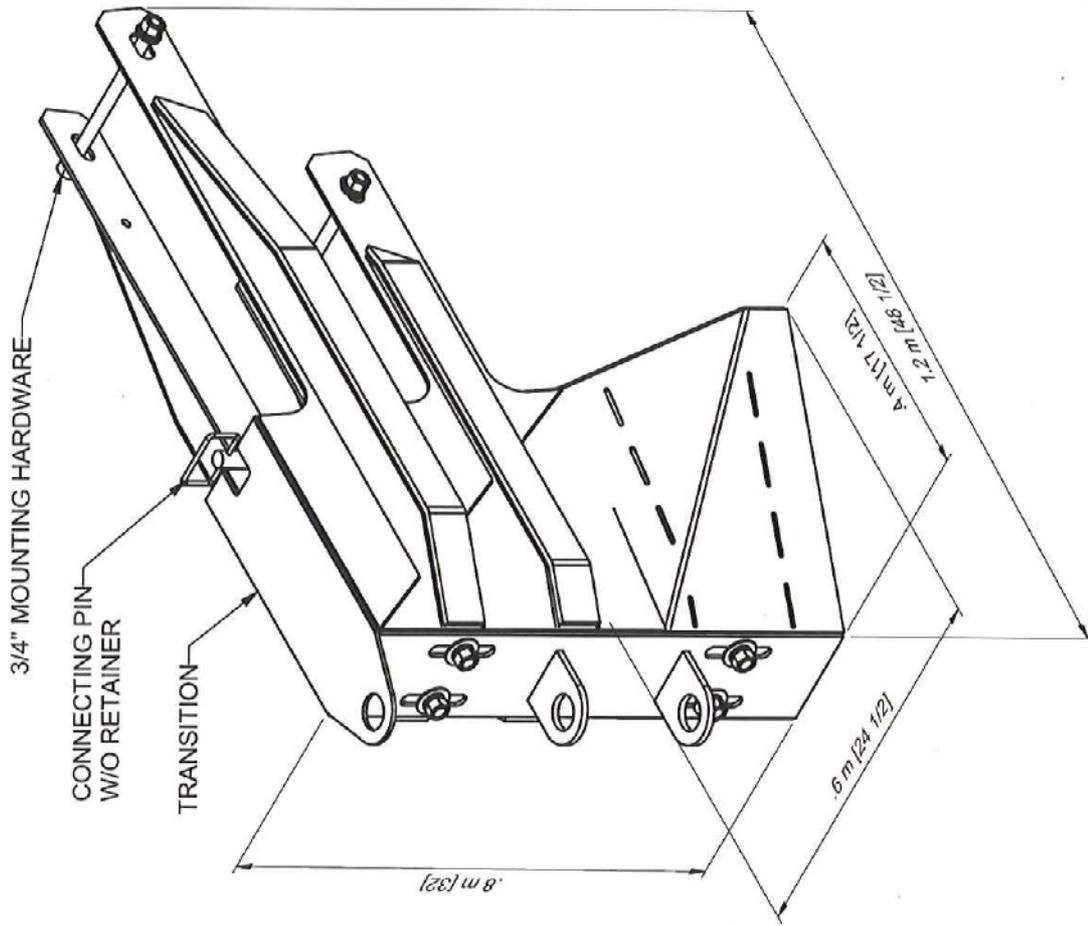
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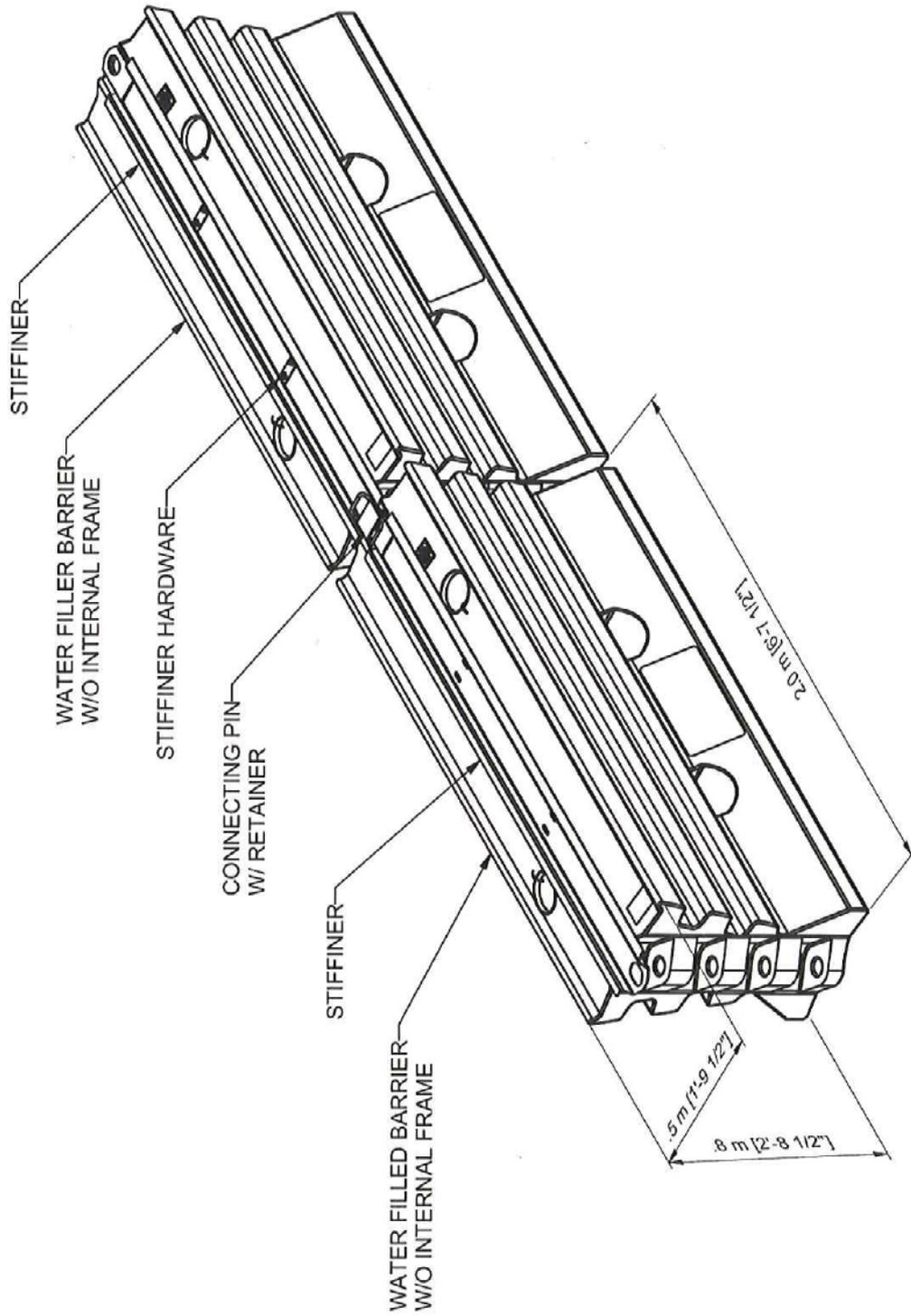
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| DATE   | 11/13/2008 | ENERGY ABSORPTION SYSTEMS, INC.<br>ENGINEERING AND RESEARCH DEPARTMENT |
| DRAWN BY   | aaaron.cox | ACZ-350 SECTION 2  |
| DESIGNED BY  | aaaron.cox |  |
| CHECKED BY   |            |  |
| APPROVED BY  |            |  |
| D.C.   |            |  |
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Figure 4



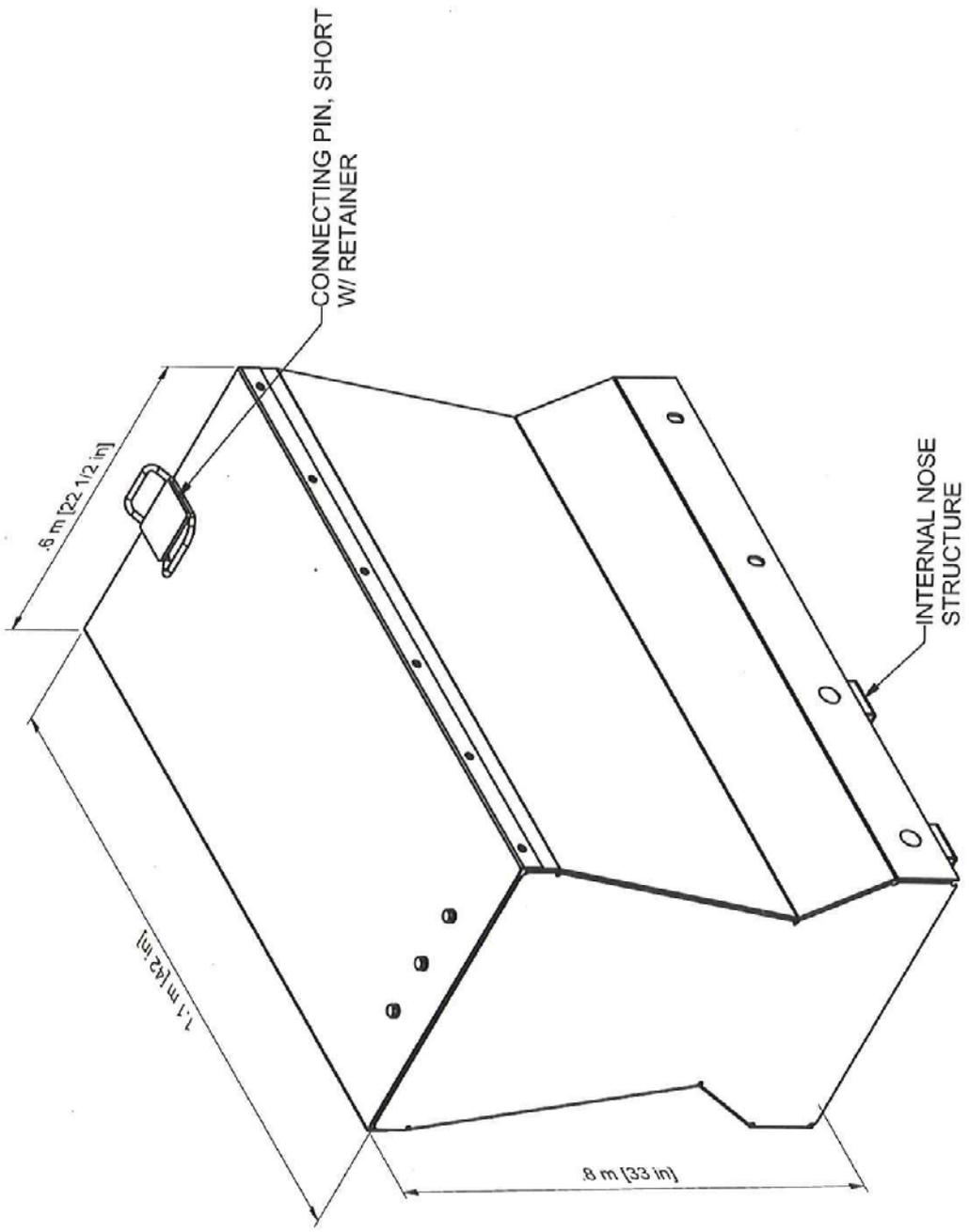
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| <h2>ACZ-350 TRANSITION ASSY</h2>   |  |   |
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Figure 3



|   |                  |  |     |
|---|------------------|--|-----|
| DESIGN: aaron.cox   | DATE: 11/12/2008 | ENERGY ABSORPTION SYSTEMS, INC.<br>ENGINEERING AND RESEARCH DEPARTMENT |     |
| DRAWN: aaron.cox  | DATE:            | ACZ-350 SECTION 1  |     |
| CHECKED:  | DATE:            |  |     |
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| D.S.:   | DATE:            |  |     |
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|   |                  |  | R/W |

Figure 2



|   |  |                  |  |               |
|---|--|------------------|--|---------------|
| DRAWN: aaron.cox  |  | DATE: 11/12/2008 | ENERGY ABSORPTION SYSTEMS, INC.<br>ENGINEERING AND RESEARCH DEPARTMENT |               |
| DESIGNED: aaron.cox   |  | DATE:            | ACZ-350 NOSE ASSY  |               |
| CHECKED:  |  | DATE:            |  |               |
| APPROVED:   |  | DATE:            |  |               |
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| DATE:   |  | DATE:            |  |               |
| UNLESS OTHERWISE NOTED, ALL DIMENSIONS ARE IN INCHES.<br>DIMENSIONS ACCORDING TO ASME Y14.5M-1994 UNLESS OTHERWISE SPECIFIED. |  |                  | DRAWINGS:  | SHEET: 1 of 1 |

Figure 5

NCHRP 350  
TEST MATRIX

TERMINALS & CRASH CUSHIONS

NONREDIRECTIVE GATING

TL-3 (100 km/h = 62.1 mph)

ACZ-350 SYSTEM



\* F FOR TL-2 & TL-3; G FOR TL-1

PASSED

TEST 3-40  
820C/100 km/h/0°  
C,D,F\*,H,I,(J),K,N



PASSED

TEST 3-41  
2000P/100km/h/0°  
C,D,F\*,H,I,(J),K,N



PASSED

TEST 3-44  
2000P/100km/h/20°  
C,D,F\*,K,N

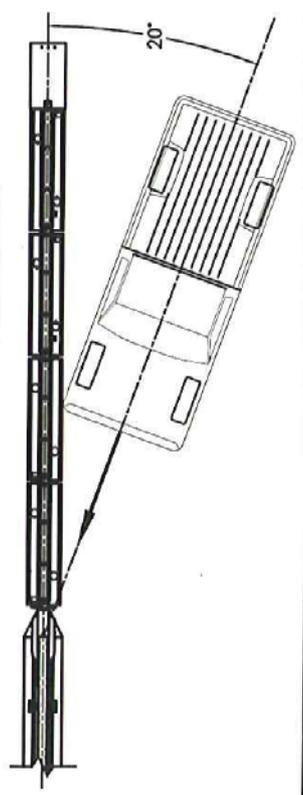
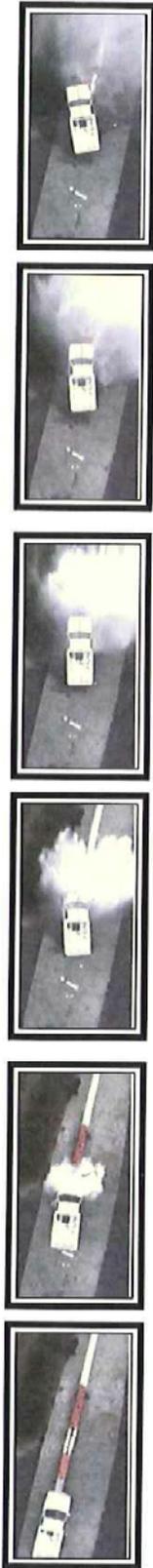


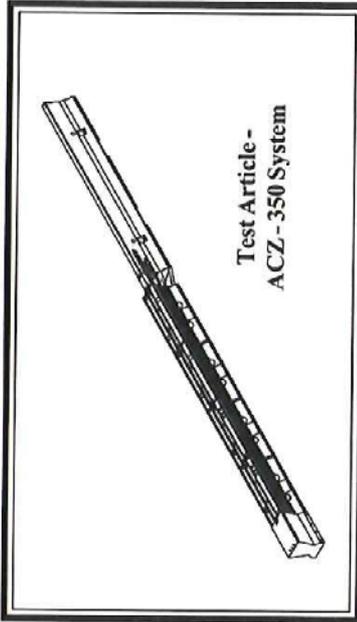
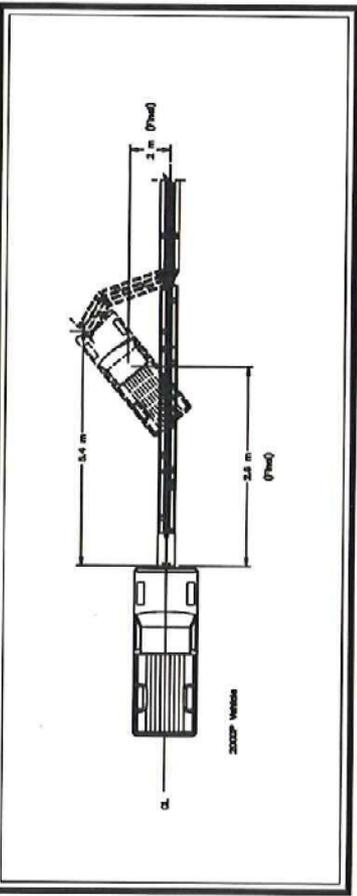
Figure 6







t = 0.000 sec      t = 0.210 sec      t = 0.420 sec      t = 0.630 sec      t = 1.260 sec



**General Information**

Test Agency ..... E-TECH Testing Services, Inc.  
 Test Designation ..... NCHRP 350 Test 3-41  
 Test No. .... 01-4317-001

Date ..... 10/30/08  
 Test Article Type ..... Energy Absorption System  
 Installation Length, ..... ACZ - 350 System

Material and key elements ..... 9.0 m - (4) segment total, pinned and freestanding w/ steel nose  
 ..... Polyethylene plastic segments (4 water-filled), first two w/o frame and steel side straps, last two with, 14 ga hollow steel nose, transition to (3) 3 m freestanding PCMB with last section anchored

Foundation Type and Condition ..... Segment Length x Width x Height: (2021 mm x 533 mm x 813 mm)  
 ..... Portland Cement Concrete, clean and dry, unanchored

Test Vehicle Type ..... Production Model  
 Designation ..... 2000P  
 Model ..... 1988 Chevrolet C2500 Pickup

Mass (kg) .....  
 Curb ..... 1853  
 Test inertial ..... 1995  
 Dummy ..... N/A  
 Gross Static ..... 1995

**Impact Conditions**

Speed (km/h) ..... 98.3  
 Angle (deg) ..... 0  
 Impact Severity (kJ) ..... 744.0

Exit conditions  
 Speed (km/h) ..... N/A  
 Angle (deg - veh. e.g.) ..... N/A

Occupant Risk Values  
 Impact Velocity (m/s)  
 x-direction ..... 9.9  
 y-direction ..... -0.3

Ridedown Acceleration (g's)  
 x-direction ..... -11.1  
 y-direction ..... -5.7

European Committee for Normalization (CEN) Values  
 THIV (km/h) ..... 35.6  
 PHD (g's) ..... 11.2  
 ASI ..... 0.9

Post-Impact Vehicular Behavior (deg - rate gyro)  
 Maximum Roll Angle ..... -7.6  
 Maximum Pitch Angle ..... 20.0  
 Maximum Yaw Angle ..... -39.2

Test Article Deflections (m)  
 Dynamic ..... 5.4  
 Permanent ..... 5.4

Vehicle Damage (Primary Impact)  
 Exterior  
 VDS ..... FD-4  
 CDC ..... 12FDEW4

Interior  
 VCDI ..... AS0000000  
 Maximum Deformation (mm) ..... 14

Figure 6. Summary of Results - ACZ - 350 System Test 01-4317-001