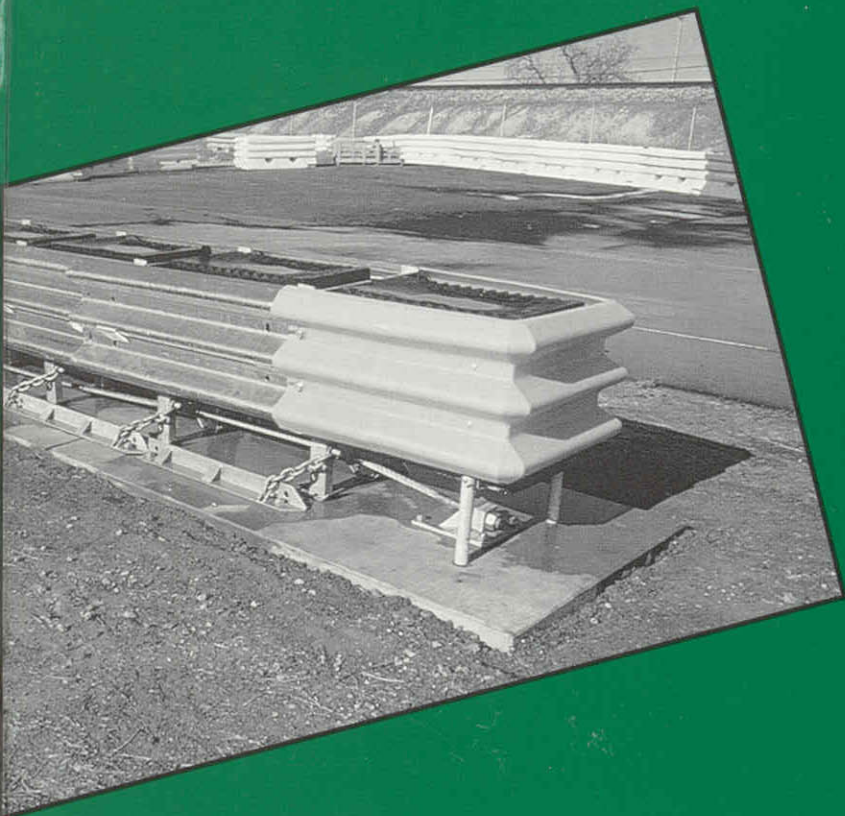


G-R-E-A-T[®] System



*Designed for Maximum Lifesaving
Efficiency*



**ENERGY ABSORPTION
SYSTEMS, INC.**

Saving Lives by Design

M A I N T E N A N C E

General Information

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Important Introductory Notes

Proper maintenance of the G-R-E-A-T System is essential to assure maximum performance. Take the time to review the maintenance/refurbishment instructions and product limitations thoroughly before performing the necessary work. Do not attempt to maintain/refurbish any crash cushion without the proper plans and maintenance manual from the manufacturer.

If you need additional information, or have questions about the G-R-E-A-T System, please call Energy Absorption Systems' **Customer Service Department at 1-888-32-ENERG.**

System Overview

The G-R-E-A-T System (Guardrail Energy-Absorbing Terminal) is a highly efficient, redirective, non-gating crash cushion. It is ideal for narrow hazards from 610 to 915 mm (2 to 3 ft) wide.

The system consists of crushable Hex-Foam[®] cartridges surrounded by three beam fender panels. Its modular design allows the system length to be tailored to the design speed at a specific site. The system measures from 1.8 to 12.2 m (6 to 40 ft) in length, depending on the number of bays required by

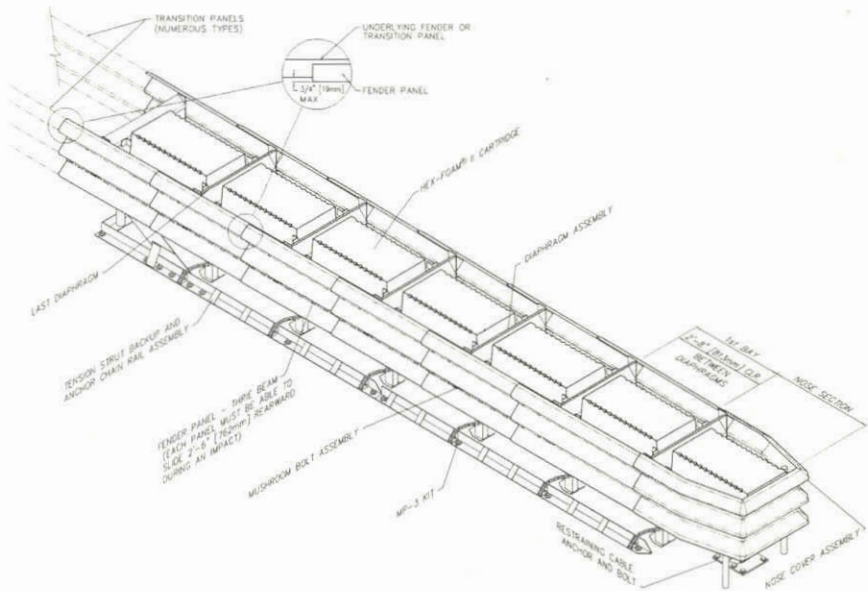
the design speed. The system is available in three standard widths: 610 mm, 762 mm and 915 mm (2', 2'6", and 3').

Refer to Figure 1 for a system diagram of the G-R-E-A-T System, highlighting its key components.

Crash Performance

The G-R-E-A-T System is a redirective, non-gating attenuator system. It safely decelerates a wide range of vehicles for design speeds up to 113 km/h (70 mph). When hit head-on, the system's Hex-Foam cartridges crush to dissipate the energy of impact,

Figure 1



G-R-E-A-T System Diagram



The G-R-E-A-T[®] System

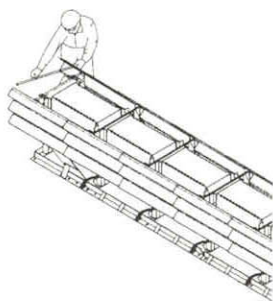
General Information

while the steel fender panels telescope. Only the cartridges and plastic nose are expended.

When impacted from the side, the system safely redirects the vehicle, preventing it from gating through and causing secondary accidents.

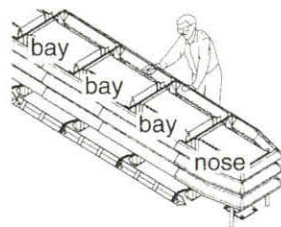
Measuring the System

The G-R-E-A-T System is available in three standard widths: 610, 762 and 915 mm (2', 2'6", and 3') and can range in length from one bay (24 km/h, 15 mph) to 12 bays (113 km/h, 70 mph). To determine the system's width, measure from the inside right fender panel to the inside left fender panel.



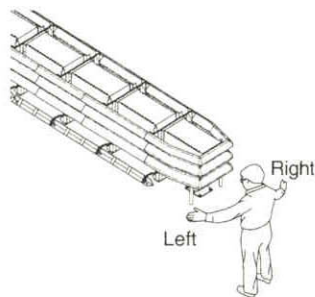
Measuring System Width

The G-R-E-A-T System's length is determined by the number of bays required by your site. One bay consists of one cartridge, one diaphragm, two fender panels, etc. Count the cartridges and subtract one (for the nose). If the cartridges are not in place, count the number of fender panels on one side.



Counting Bays

When ordering parts for the G-R-E-A-T System, stand in front of the system facing the hazard. Your left is the system's left and your right is the system's right.



Determining left/right

Maintenance Checklists

Maintenance Checklists

It is important to inspect the G-R-E-A-T System often because an impact can occur at any time. Two types of inspections should be performed regularly:

- Visual Drive-By Inspection
- Walk-Up Inspection

Visual Drive-By Inspection Checklist

Drive-by inspections are recommended as needed based on volume of traffic and frequency of impacts. If any of the following conditions are noticed, a walk-up inspection is warranted. Required corrections must be made as soon as possible.

1) Check for evidence of impact

Check to see if there is evidence of an impact. If so, a walk-up inspection will be necessary.

2) Check restraining chains

Be sure all the chains are in the proper position with the last link over the pin on the lower portion of the support legs. Make certain this is done on both sides.

3) Check cartridges

Check to see if the cartridges appear to be off the support brackets. Any damaged cartridges will need to be replaced.

4) Check the nose

Be sure the plastic nose cover is in place.

Note: The nose of the unit should be delineated to comply with local codes (chevron, reflectorized sign, etc.)

5) Note the location

Note the location and condition of the G-R-E-A-T System and the date of the visual drive-by inspection in your maintenance log.



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1-888-32-ENERG

Maintenance Checklists

Walk-Up Inspection Checklist

Physical inspections are recommended as needed based upon traffic volume and impact history. If system repairs are necessary, refer to the Refurbishment instructions in this manual. Complete the following steps during a walk-up inspection:

1) All bolts securely/properly fastened, aligned and rust-free

- Be sure all bolts are tight and rust-free.
- Be sure concrete anchor bolts are securely anchored.
- Be sure all mushroom bolts are properly aligned and positioned in the correct slot in the underlying thrie-beam panel.

2) Diaphragm legs straight

Be sure diaphragm legs are straight.

3) Mushroom deflectors in place

Be sure all mushroom deflectors are in place and properly positioned on each fender panel (except rear-most panel).

4) Restraining cable tight and rust-free

Be sure restraining cable is tight and rust-free. If necessary, to tension the cable, refer to the Installation Manual.

5) Cartridges undamaged and in position

Be sure the cartridges have not been damaged and are properly positioned in their support brackets. Replace crushed or sagging cartridges. To ensure 100% of the full design speed characteristics, partially crushed cartridges (due to slow speed impacts) should be replaced. Look for staples that have broken or pulled out along the bottom edge of the cartridges.

6) Fender panel gaps within tolerances

Check the maximum gap of the fender panels. The maximum recommended gap for overlapping parts (including fender panels overlapping the transition panels or components behind the unit) is:

- 19 mm +/- 6 mm (3/4" +/- 1/4") on any side where traffic approaches from the rear.
- 38 mm (1-1/2") maximum on any side where traffic approaches the nose head-on.

7) Repairs required

Make all necessary repairs as described above. Refer to page 9 for Refurbishment procedures and the Installation Manual for more information.

8) Note the location

Note the location and condition of the G-R-E-A-T System, the date and any work that is done in your maintenance log. If further repair is required, note the repair request date in your log.

Parts Ordering Procedures

When the G-R-E-A-T System has been impacted or requires repair, replacement parts can be ordered. To order parts or ask questions, call Energy Absorption Systems' **Customer Service Department at 1-888-32-ENERG**. Diagrams of the G-R-E-A-T System backups and transitions are provided at the back of this manual for reference in identifying system components.

Complete the following steps to order parts for the G-R-E-A-T System:

- 1) Make a list of all damaged parts using the part descriptions shown on pages 8 through 13. Fill in the chart in Figure 2. (Figure 3 shows an example of a completed chart.) This information is necessary to receive the proper parts.
- 2) To determine width and number of bays, refer to page 4.



Figure 2

DESCRIPTION	CHOICES	FILL IN THIS SECTION
Width of unit? (refer to "Determine Width" page 4)	610 mm [2'-0"] 762 mm [2'-6"] 914 mm [3'-0"]	
Number of bays (refer to "Determine Number of Bays" page 4)	1 thru 12	
Type of backup? (refer to pages 12 & 13)	Tension strut G-R-E-A-T [®] cz Concrete New Jersey Wide flange	
Transition panels? -Right side -Left side -Both sides -No Transition (refer to page 13)	4" offset 9" offset Thrie to w Rear deflector	

G-R-E-A-T System Ordering Information Chart

Figure 3

DESCRIPTION	CHOICES	FILL IN THIS SECTION
Width of unit? (refer to "Determine Width" page 4)	610 mm [2'-0"] 762 mm [2'-6"] 914 mm [3'-0"]	2'-6"
Number of bays (refer to "Determine Number of Bays" page 4)	1 thru 12	3
Type of backup? (refer to pages 12 & 13)	Tension strut G-R-E-A-T [®] cz Concrete New Jersey Wide flange	Tension strut
Transition panels? -Right side -Left side -Both sides -No Transition (refer to page 13)	4" offset 9" offset Thrie to w Rear deflector	None

Example of Completed Chart

Refurbishment

Required Tools

1. Traffic control equipment
2. Pickup truck or similar vehicle
3. Ratchet (1/2")
4. 13 x 610 mm (1/2" x 24") breaker bar
5. 1/2" drive sockets (9/16", 11/16", 3/4", 7/8", 15/16", 1-1/8")
6. Box/open-end wrenches (9/16", 11/16", 3/4", 7/8", 15/16", 1-1/8")
7. Large screwdriver or drift pin
8. Allen wrench (3/8")
9. 2 kg (4-lb) hammer
10. 6096 mm (20-ft) chain with hooks (13 mm, 1/2")
11. Two pipe wrenches 610 mm (24")
12. Crescent wrench 305 mm (12")
13. 1800 mm (6-ft) pry bar
14. Torque wrench 300 Nm (200 ft-lbs)

Refurbishment Procedures

When refurbishing the G-R-E-A-T System, complete the following steps. Additional information is available in the G-R-E-A-T System Installation Manual, if required.

1) Set up traffic control

Set up traffic control to protect your crew.

2) Clear debris from site

3) Check anchor bolts

Check to see that all anchor bolts remain firmly anchored in the roadway surface. Replace any that are loose, broken or pulled out. The proper impact performance of the unit during angle impacts depends on the front and rear cable anchors being properly anchored. Refer to Figure 4 for torque values.

Note: If the system is anchored in asphalt, it should be relocated to fresh, undisturbed asphalt after each



For Customer Service Call
1-888-32-ENERG

Refurbishment

impact to insure adequate future impact performance. The 460 mm (18") threaded rods or anchor pins should then be installed.

Figure 4

Restraining Cable	Torqued to 203 Nm (150 ft-lbs)
Mushroom Bolt Assemblies	Torqued to 81 Nm (60 ft-lbs)
Anchor Bolts	Torqued to 163 Nm (120 ft-lbs)
All other Bolts	Tightened
Chains	In place on pins
Fender Panel	19 mm (3/4") max gap allowed

Checking the G-R-E-A-T System

4) Check mushroom bolt assemblies

Check the unit to be certain that the mushroom bolt assemblies holding the fender panels together are still intact and that the unit has not been deformed in a fashion that would prevent pulling it back to its original position. Refer to Figure 4 for torque values.

Warning:

Do not fasten the last fender panel rigidly to the hazard with additional fasteners besides the mushroom assembly. The last panel must be able to slide to allow the last cartridge to be crushed.

Caution: During assembly of the G-R-E-A-T System, be sure the holes labeled "G" are used to attach the fender panels to the diaphragms. If the holes labeled "S" are accidentally used, the cartridges will not fit.

5) Check diaphragm support legs

Be sure that the diaphragm support legs are all between the parallel restraining chain rails. If they are outside the rails, the unit should be moved laterally until it is centered.

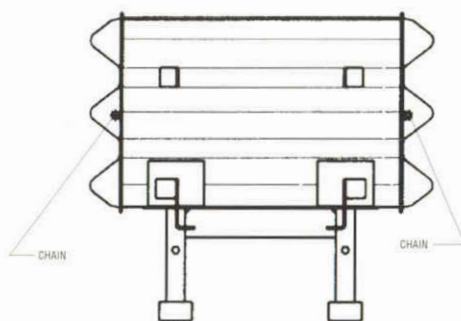
6) Pull out unit to its original position

Wrap a chain around the front diaphragm, placing the chain between the diaphragm side plate and the thrie beam center. Attach

both ends of the chain to a pullout vehicle. Drive forward slowly until the unit reaches its original length. Refer to Figure 5.

Have someone watch the unit during repositioning to be certain that previously undetected damage does not cause the unit to pull out improperly.

Figure 5



Chain Placement for Repositioning

Warning:

Stand clear of the pull-out chain in case it breaks or becomes disconnected.

7) Remove crushed cartridges

Remove all crushed cartridges from within the unit. Check to see that the diaphragms are in usable condition and that the fender panels are properly attached with the mushroom bolt assemblies.

Note: Frequently, parts deformed during an impact can be straightened and reused.

8) Check fender panel gaps

Check the gap of the fender panels. The maximum recommended gap for these overlapping parts (including fender panels overlapping components behind the unit) is shown in Figure 5.

Be sure the mushroom bolt assemblies are torqued to 80 Nm (60 ft-lbs). If the gaps between the fender panels are still too large, it may be necessary to replace the bent parts.

9) Replace crushed cartridges

Replace all crushed cartridges.



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1-888-32-ENERG

Backups

10) Replace nose

Replace the plastic nose. Attach the new nose to the front diaphragm, using the four 3/4" diameter bolts that hold the front fender panels to the first diaphragm. Torque the 3/4" bolts to approximately 34 Nm (25 ft-lbs).

11) Restore restraining chains

Restore each of the restraining chains to its proper position by placing the last link over the pin on the lower portion of the support legs. Make certain this is done on both sides. It may be necessary to temporarily remove the pins in the chain rail.

12) Check restraining cable and anchors

Check to make sure that the restraining cable anchors are intact and that the cable is tight. Refer to Figure 5 for torque values.

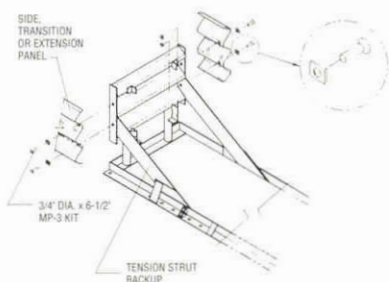
13) Clean up site

Check to be sure that the site is free from any debris. The G-R-E-A-T System is now ready for use again.

Backups

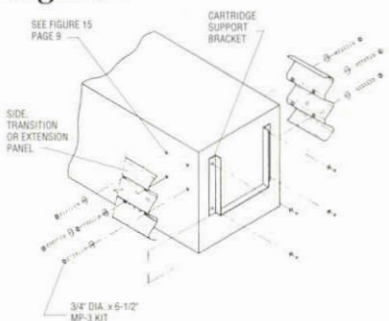
There are four types of backups available for the G-R-E-A-T System; the type of backup used is determined by the type of hazard. Backups include a Tension Strut Backup, Concrete Backup, New Jersey Backup and Wide Flange Backup. Figures 6-9 are sketches of the four G-R-E-A-T System backups and are provided for identifying the parts.

Figure 6



Tension Strut Backup

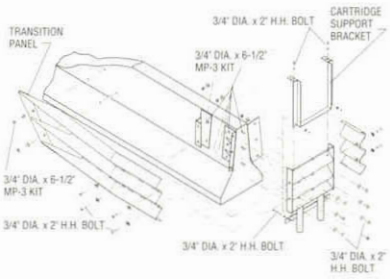
Figure 7



Concrete Backup Assembly

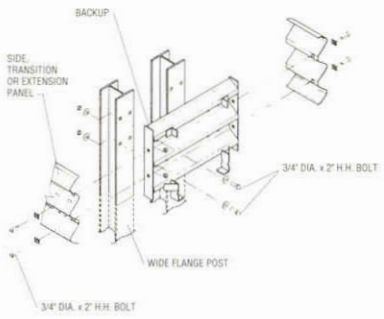
Transitions

Figure 8



**New Jersey Backup Assembly
for Bi-directional Units**

Figure 9

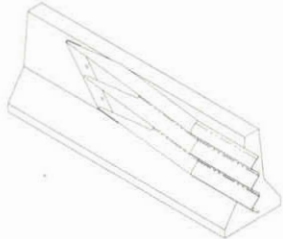


Wide Flange Backup Assembly

Transitions

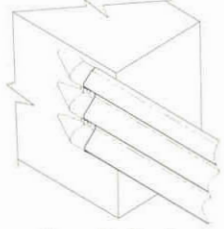
The following are drawings of typical G-R-E-A-T System transitions. Refer to Figures 10-12 to identify the G-R-E-A-T System transition.

Figure 10



Offset Panel

Figure 11



Rear Deflector

Figure 12



Thrie to W

Limitations and Warnings

The G-R-E-A-T[®] System has been tested and evaluated per the recommendations of the National Cooperative Highway Research Program (NCHRP) Report 230** . The 6 bay G-R-E-A-T System, as an example and as currently designed, is capable of decelerating and stopping light and heavy weight vehicles (816 and 2041 kg [1800 and 4500 lb]) when impacted head-on at 97 km/h (60 mph); and redirecting light and heavy weight vehicles (816 and 2041 kg [1800 and 4500 lb]) when impacted at 97 km/h (60 mph) along the system's side for right way impacts of 20 degrees or less and wrong way impacts at an angle of 15 degrees or less. Tests are conducted on slopes less than 8 degrees and without curbs.

The Design Table in Figure 13 is recommended for determining the minimum number of bays required for a given speed, e.g., a minimum of 6 bays are required for 97 km/h (60 mph). Use of a wider or longer crash cushion than necessary can also create a hazard and is NOT recommended.

Limitations and Warnings

On a bidirectional installation, a smooth transition must be provided between the longitudinal barrier and the G-R-E-A-T System. The transition must be either a transition panel or formed concrete. This transition panel may be purchased as an extra piece of hardware from Energy Absorption Systems, Inc., or provided by the customer.

The Hex-Foam[®] II cartridge can only be used in G-R-E-A-T Systems or G-R-E-A-T cz Systems that have been fitted or retrofitted with a 22 mm (7/8") diameter restraining cable and with cartridge support brackets.

Note: G-R-E-A-T Systems with three or fewer cartridges do not require a restraining cable.

Cartridges need to be replaced after an impact to ensure the energy absorbing capacity of the unit is 100% of its potential.

Excessive curb height may create a ramping effect, which could create an unsafe vehicle trajectory.

Impacts that exceed the design capabilities described in this manual (vehicle weight, speed and impact angle) may not result in acceptable crash performance as described in NCHRP 230 relative to structural adequacy, occupant risk and vehicle trajectory factors.

Warning:

Do not fasten the last fender panel rigidly to the hazard with additional fasteners besides the mushroom assembly. The last panel must be able to slide to allow the last cartridge to be crushed.

Caution: During assembly of the G-R-E-A-T System, be sure the holes labeled "G" are used to attach the fender panels to the diaphragms. If the holes labeled "S" are accidentally used, the cartridges will not fit.

*** Copy may be obtained from:
Transportation Research Board
National Research Council
2101 Constitution Avenue, N.W.
Washington, D.C. 20418*

Limitations and Warnings

Figure 13

No. of bays	Nominal length	Design [km/h] Velocity [mph]	24 15	32 20	40 25	48 30	56 35	64 40	72 45	80 50	88 55	97 60	105 65	113 70
12	(38'-9") [11 811 mm]	G's KIPS*	—	—	—	—	—	—	—	—	—	—	—	5.0 33.8
11	(35'-9") [10 897 mm]	G's KIPS*	—	—	—	—	—	—	—	—	—	—	—	5.4 36.5
10	(32'-9") [9982 mm]	G's KIPS*	—	—	—	—	—	—	—	—	—	—	5.1 34.4	5.9 39.8
9	(29'-9") [9068 mm]	G's KIPS*	—	—	—	—	—	—	—	—	—	4.8 32.4	5.6 37.8	6.5 43.9
8	(26'-9") [8153 mm]	G's KIPS*	—	—	—	—	—	—	—	—	4.4 29.7	5.3 35.8	6.2 41.9	7.2 48.6
7	(23'-9") [7239 mm]	G's KIPS*	—	—	—	—	—	—	—	4.1 27.7	5.0 33.8	6.0 40.5	7.0 47.3	8.1 54.7
6	(20'-9") [6325 mm]	G's KIPS*	—	—	—	—	—	3.8 25.7	4.7 31.7	5.7 38.5	6.8 45.9	8.0 54.0	9.3 62.8	—
5	(17'-9") [5410 mm]	G's KIPS*	—	—	—	—	—	3.6 24.3	4.5 30.4	5.6 37.8	6.7 45.2	8.0 54.0	9.4 63.5	10.8 72.9
4	(14'-9") [4496 mm]	G's KIPS*	—	—	—	—	3.3 22.3	4.3 29.0	5.4 36.5	6.7 45.2	8.1 54.7	9.5 64.8	11.3 76.3	—
3	(11'-9") [3581 mm]	G's KIPS*	—	—	—	3.0 20.3	4.1 27.7	5.4 36.5	6.8 45.9	8.4 54.7	10.1 68.2	12.0 81.0	—	—
2	(8'-9") [2667 mm]	G's KIPS*	—	—	2.8 18.9	4.0 27.0	5.5 37.1	7.2 48.6	9.1 61.4	11.2 75.6	—	—	—	—
1	(5'-9") [1753 mm]	G's KIPS*	1.5 10.4	2.7 18.2	4.3 29.0	6.2 41.9	8.4 56.7	10.9 73.6	—	—	—	—	—	—

G-R-E-A-T System Design Table

* To find equivalent metric force on the backup in kilo-Newtons (kN), multiply the above KIP values by 4.448. Above G's are average values calculated for vehicles 817 to 2041 kg [1,800 to 4,500 lbs that stop in a distance equal to 85% of the unit's length.

Warning:

Shaded area denotes excessive decelerations based upon occupant risk recommendations outlined in NCHRP 230 for 2041 kg (4500 lb) vehicles. Energy Absorption Systems, Inc. does not recommend choosing units from this area of the chart.



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