

# QUEST<sup>®</sup> CEN System



*Redirective, Bidirectional Crash Cushion*



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*Saving Lives By Design*

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# Product Manual

# QUEST® CEN System

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*Note: This manual and the standard drawings with their reference drawings in PDF format are also contained on the CD included on the inside back cover of this manual.*

### Important Introductory Notes

Proper installation of the QUEST CEN System is essential to assure maximum performance. Take the time to review the installation instructions and product limitations thoroughly before performing the necessary work. Do not attempt to install any crash cushion without the proper plans and installation manual from the manufacturer.

*Note: The drawing package provided with the QUEST CEN System should take precedence over the drawing package provided in this manual. These drawings are for reference only and may not be up to date.*

If you need additional information, or have questions about the QUEST CEN System, please call Energy Absorption Systems' Customer Service Department at +44 (0) 1473 221105 or contact your local Energy Absorption Systems Distributor.

### System Overview

The QUEST CEN System is a highly efficient, redirective, non-gating crash cushion designed to shield hazards 610mm (24") or less in width. The steel backup is designed to be placed against and nest around the hazard, resulting in a shorter overall installation length.

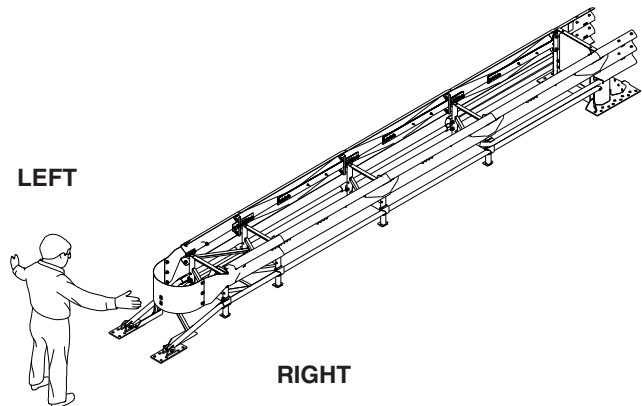
### Crash Performance

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

During head-on impacts, the QUEST CEN System telescopes rearward and the shaper rails are deformed to absorb the energy of impact. When impacted from the side, it safely redirects the vehicle back toward its original travel path and away from the hazard.

### How to Determine Left/Right

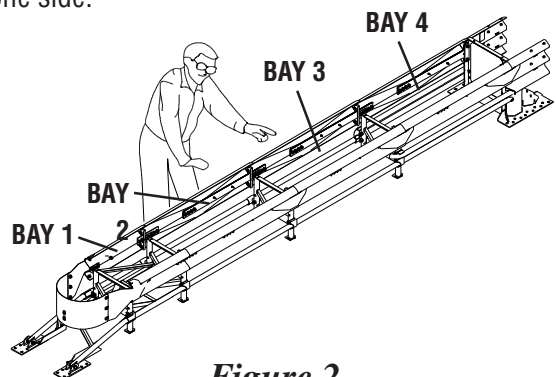
To determine left from right when ordering transitions, stand in front of the system facing the hazard. Your left is the system's left and your right is the system's right.



*Figure 1*

### Defining the Bays

Bay 1 consists of a steel framework, bays 2, 3 and 4 consists of one diaphragm and two fender panels. Determine the number of bays by counting the fender panels on one side.



*Figure 2*

# QUEST<sup>®</sup> CEN System

## General Product Specifications

### I. GENERAL

All QUEST CEN Systems are designed and manufactured by, or under the direction of, Energy Absorption Systems, Incorporated, of Chicago, Illinois.

### II. DESCRIPTION OF SYSTEM

#### A. General

The QUEST CEN System is a bi-directional redirective terminal and crash cushion that has been crash tested to EN 1317-3:2000 for the impact conditions listed in Table 1 in section IV of this specification. The QUEST CEN System consists of two front anchor assemblies, a nose assembly containing an integrated trigger assembly, two shaper rail assemblies, a support frame assembly with two energy absorbing tube shapers, a diaphragm assembly, laminated sheet metal straps attaching to the W-beam fender panel assemblies which can telescope rearward during head-on impacts, two rear rails, and a freestanding backup assembly which will include two rear shapers on 110 km/h models. The system of front anchors, shaper rails, rear rails, backup, W-beam fender panels, and diaphragms resists lateral movement during side angle impacts. These components acting with the nose assembly will telescope rearward to attenuate head-on impacts. Thus the QUEST CEN is designed to collapse at the front and then the rear depending on the amount of impact energy absorbed. The Support Frame is the only section that does not collapse. The Shaper Rail attaches to Front Anchors in the front and to the Backup at the rear. The Shaper Rails are deformed by a set of Shapers that absorb impact energy. Transitions are available and may be required depending on the hazard being shielded.

#### B. Component description

1. A bay describes an individual section of the QUEST CEN System. There are four bays in the QUEST CEN 100 and 110 models and three bays in the QUEST CEN 80 model.
  - a. Bay 1 consists of a 915 mm long rigid Support Frame that tracks along energy absorbing Shaper Rails which also resist overturning and gating during frontal impacts into the system.
  - b. Bay 2 (and Bay 3 in the 100 and 110 km/h models) is 1830 mm long and forms the middle portion of the crash cushion. The Bay consists of a diaphragm, laminated sheet metal straps and two reinforced W-beam fender panels.
  - c. Bay 4 (Bay 3 in the 80 km/h model) is 1830 mm long and is equipped with an additional set of rails along with a diaphragm, laminated sheet metal straps and two reinforced W-beam fender panels and forms the rear portion of the crash cushion.
2. The rear rails and the shaper rails are made of steel tubing. The shaper rails are attached to the front anchor assembly and the backup per manufactures instructions. The rear rails are attached to the 3rd diaphragm (2nd diaphragm in the 80 km/h model). The rear rails for the 110 km/h model are pre-crimped on one end and slide through shapers, which are attached to the backup.

1 European Committee for Standardisation (CEN) EN 1317. "Road restraint systems - Part 3: Performance classes, impact test acceptance criteria and test methods for crash cushions." Central Secretariat, rue de Stassart, 36 B-1050 Brussels, May 2000.

# QUEST® CEN System

## General Product Specifications (cont'd.)

3. The nose section is fabricated from sheet metal. The nose is connected to the W-beam panels in bay one and is not counted as a bay. The nose is connected to the trigger.
4. The trigger is made of steel, high strength threaded rods. The trigger is able to maintain high tensile forces in order to redirect vehicles in a design impact. The trigger breaks free to allow rearward movement during design impacts on the nose.
5. The diaphragms are constructed of steel and attach to the shaper rail by means of a steel rail guide.
6. The fender panels are constructed of AASHTO M180 Class A w-beam reinforced with additional steel welded to the back of the w-beam. Each fender panel overlaps the rearward fender panel. Each fender panel has steel guards attached to the rear of the panel which covers the forward connecting bolts of the subsequent panel. The panel is bolted to a diaphragm by means of three 5/8" bolts.
7. The laminated straps are constructed of galvanized sheet steel and are bolted together to connect the W-beam fender panels.
8. Rear shapers are made of steel and consists of four vanes. The shapers are attached to the backup per the manufacturer's instructions for the 110 km/h model.
9. The backup structure is made of steel and has integral anchor plates. The backup has a nominal width of 610 mm.

### C. Material Specifications

1. The w-beam panel material specification is the industry standard AASHTO M180 Class A (12ga).
2. The rail and diaphragm tubing material and wall thickness specification is per ASTM A500 GR B.
3. The nose and diaphragm sheet metal material and thickness specification is per ASTM A569.
4. All other flat bar or plate steel specification is per ASTM A36.
5. The fasteners at the anchor/rail connection are specified as SAE J429 GD 8 and all others as SAE J429 GD 5.
6. All steel components are specified hot dipped galvanised after fabrication per ASTM A123.
7. All welding is done by or under the direction of a certified welder.

## III. PERFORMANCE CRITERIA

- A. The QUEST® CEN systems are capable of meeting the performance criteria stipulated in EN 1317-3:2000, for velocity classes of 110 km/h, 100 km/h, and 80 km/h, with vehicles weighing between 900kg and 1500kg. A properly installed and maintained QUEST CEN System is capable of performing its functions of stopping or containing and redirecting the test vehicles to the EN 1317-3:2000 requirements.
- B. The QUEST CEN System is designed and constructed so that there is no debris released from the system which can create a hazard on the roadway after either head-on or side angle design impacts.

# QUEST® CEN System

## General Product Specifications (cont'd.)

### IV. TEST CRITERIA

The following full-scale crash tests have been conducted on the QUEST® CEN System, and in each test all evaluation criteria specified in EN 1317-3:2000 were met. Properly installed and maintained, the QUEST CEN System is capable of performing its functions of stopping or containing and redirecting impacting vehicles in accordance with EN 1317-3:2000 for the impact conditions listed in Table A. The impact conditions tested are intended to represent a wide range of in-service impact conditions, but do not encompass all possible in-service impact conditions.

<b>Table A -- SUMMARY OF QUEST CEN EN 1317 TESTS</b>				
<b>Performance Level</b>	<b>EN 1317 Test No.</b>	<b>Vehicle Mass (kg)</b>	<b>Impact speed (km/h)</b>	<b>Impact Angle &amp; Impact Point</b>
<b>110</b>	<b>Parent model at minimum taper/width - TD110CEN610</b>			
	TC 1.1.100	900	100	0 deg, head-on, centre
	TC 1.3.110	1500	110	0 deg, head-on, centre
	TC 2.1.100	900	100	0 deg, 1/4 vehicle offset
	TC 3.3.110	1500	110	15 deg, nose (centre)
	TC 4.3.110	1500	110	15 deg, redirect at L/3
	TC 5.3.110	1500	110	165 deg, redirect at L/2
	<b>Maximum taper/width model - TD110CEN610</b>			
	TC 1.1.100	900	100	0 deg, head-on, centre
	TC 4.3.110	1500	110	15 deg, redirect at L/3
<b>100</b>	<b>Minimum taper/width model - TD100CEN610</b>			
	TC 1.2.100	1300	100	0 deg, head-on, centre
	<b>Maximum taper/width model - TD100CEN610</b>			
	TC 4.2.100	1300	100	15 deg, redirect at L/3
<b>80</b>	<b>Minimum taper/width model - TD80CEN610</b>			
	TC 1.2.80	1300	80	0 deg, head-on, centre
	<b>Maximum taper/width model - TD80CEN610</b>			
	TC 4.2.80	1300	80	15 deg, redirect at L/3

### V. DESIGN AND SELECTION CRITERIA

- A. Placement of QUEST CEN System shall conform to the appropriate local regulations.
- B. Installation of the QUEST CEN System attenuators shall be accomplished in accordance with the recommendations of Energy Absorption Systems, Incorporated.

# QUEST® CEN System

## Design Criteria

The QUEST CEN System has successfully passed the European Standard EN 1317-3:2000 tests. For the full test matrix, see the Limitations & Warnings section of this manual. Impact conditions which differ from those described in the European Standard EN 1317-3:2000 may result in different crash results than those encountered in testing. Furthermore, impacts in excess of design impact severity, or cross slopes in excess of 8%, may yield crash performance which does not meet the evaluation criteria of European Standard EN 1317-3:2000.

### Special Site Conditions

Contact Energy Absorption Systems Customer Service Department if you would like assistance with your application. You will need to answer the following questions:

1. **Are curbs, islands or elevated objects (delineators or signs) present at the site? What height and width are they?** All curbs and elevated objects over 100 mm [4"] high should be removed. If possible, curbs under 100 mm [4"] high should be removed approximately 15 m [50'] in front of the QUEST CEN System, and as far back as the system's backup. Any curbs that must remain should be 100 mm [4"] maximum and be mountable.
2. **If there is a cross slope of more than 8% (4.5 degrees), a leveling pad must be used.**
3. If the installation site is a gore area, (place where two roads diverge), **what is the angle of divergence?**
4. **What is the general geometry of the site**, including the roadway for 150 m [500'] in front, so traffic patterns can be visualized?

5. **When there is an existing guardrail or median barrier at the site**, the backup of the QUEST CEN System should tie into, or nest around it when possible.
6. **Will there be traffic approaching from the rear of the system? Is the system in a two-way traffic situation, with traffic going in opposite directions on either side of the system? Or, is the system on the side of the road in a location where cross over traffic is a concern?** If so, a transition from the back of the system to the hazard is necessary to prevent vehicle snagging (see Transition Panel Types on page 7).
7. **Do the foundation requirements meet or exceed the system footing specifications on page 9?**
8. **Are there any other unique features at the site that may affect positioning or performance of the QUEST CEN System?** (See next paragraph).

### Other Factors That May Affect Your Design:

1. The existence of drain inlets.
2. Junction boxes or other items located near the hazard.
3. Insufficient space for the system length.
4. The location and movement of expansion joints.

Contact Energy Absorption Systems Customer Service Department before proceeding with your design.

For Customer Service call:  
+44 (0) 1473 221105 or call your local Energy Absorption Systems distributor.

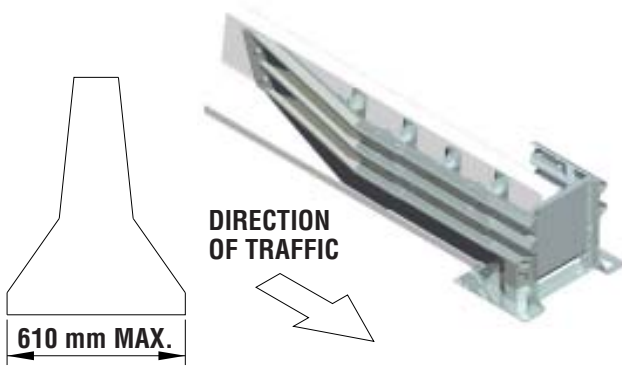
QUEST CEN Model Numbers			
Name	Model No. Unassembled	Model No. Pre-Assembled	Performance Level (km/h)
QUEST CEN 110	TD110CEN610	TD110CEN610A	110
QUEST CEN 100	TD100CEN610	TD100CEN610A	100
QUEST CEN 80	TD80CEN610	TD80CEN610A	80

# QUEST® CEN System

## Design Criteria (cont'd.)

### Transition Panel Types

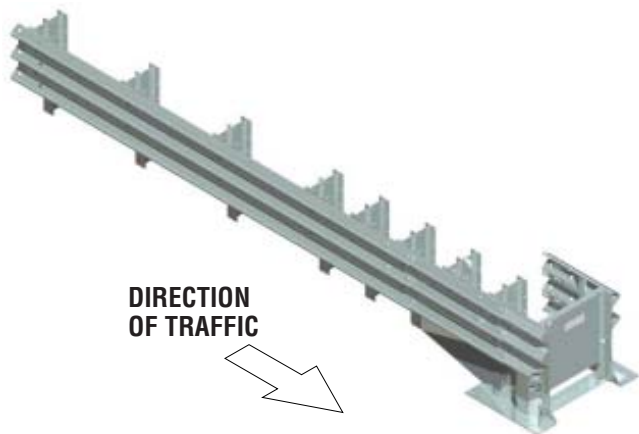
If a system is placed in a location where traffic will be approaching from the rear of the system a transition panel is necessary. Figures 3, 4, 5 & 6 show the standard panel types. There are variations for each panel type. The specific panel needed will depend on system and site conditions. **Therefore, it is important to send site specific data to Energy Absorption Systems Customer Service Department for a recommendation of the exact panel needed for your application.**



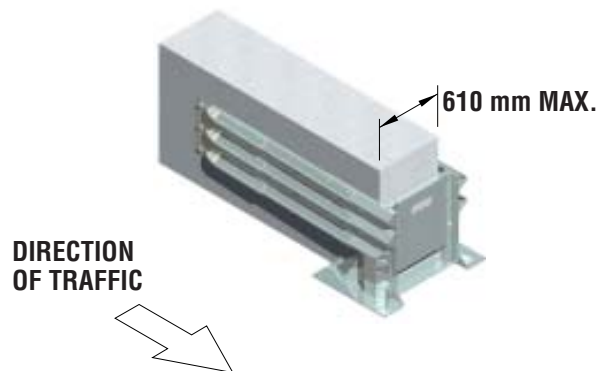
**Figure 3**  
*Thrie-Beam to Safety Barrier Transition Panel*



**Figure 4**  
*Thrie-Beam to W Transition Panel*



**Figure 5**  
*Transition to Thrie-Beam Guardrail*



**Figure 6**  
*Thrie-Beam End Shoe Transition Panel*

# QUEST® CEN System

## General Installation Information

### Required Tools

#### Documentation

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

#### Cutting equipment

- Rebar Cutting Bit - 22 mm [7/8"]
- Concrete Drill Bits - 22 mm [7/8"] (\*Two Fluted)
- Grinder, Hacksaw or Torch (optional)

\* Energy Absorption Systems recommends using two fluted drills to achieve optimum tensile strength when installing the MP-3 anchoring system.

#### Hammers

- Roto Hammer Drill
- Sledgehammer
- Standard Hammer

#### Wrenches

- Heavy Duty Impact Wrench - 1/2" Drive
- Standard adjustable wrench - 300 mm [12"]
- 1/2" drive sockets: 1 1/8", 1 1/4", 1 1/2"
- Deep Sockets: 1 1/4"
- Ratchet and attachments for the above sockets
- Breaker Bar: 1/2" x 24"
- Torque Wrench: 200 ft-lbs.
- 2 ea. Open/Box End Wrench - 3/4"

#### Safety equipment

- Safety Glasses
- Gloves

#### Miscellaneous

- Traffic Control Equipment
- Lifting and Moving Equipment (A lifting device is preferred although a forklift can be used.) Minimum 5,000 lb. capacity required.
- Compressor (100 psi) and Generator (5 KW)
- Long Pry Bar
- Drift Pin 300 mm [12"]
- Center Punch
- Tape Measure 7.5 m (25')
- Chalk Line
- Concrete Marking Pencil
- Nylon bottle brush for cleaning 7/8" drilled holes
- Rags, Water, and Solvent for Touch-up

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



# QUEST<sup>®</sup> CEN System

## Site Preparation

### Establish Required System Footing

Note that the system must be anchored. MP-3 polyester anchor bolts will be supplied for all anchorages. Refer to the QUEST CEN System Installation Manual, or MP-3 kits for detailed installation instructions.

#### 1) Is the system to be placed on existing concrete?

**Existing concrete** - Concrete must be at least 150 mm [6"] thick, reinforced 28 MPa [4000 psi] Portland cement concrete (P.C.C.), or 200 mm [8"] thick non-reinforced measuring 3.660 m [12'-0"] wide by 15.240 m [50'-0"] long. The concrete should be in good condition and be free of major cracks.

**New concrete** - If existing concrete does not meet these criteria, a new concrete pad must be placed to properly secure the system. See concrete pad drawing in the back of this manual.

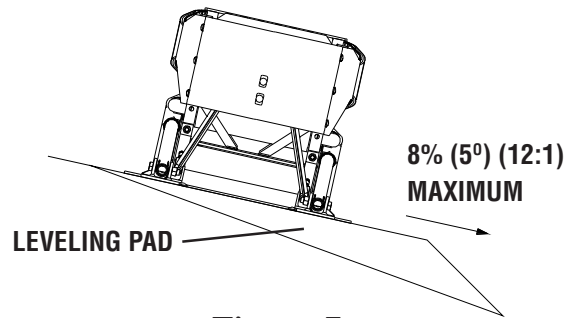
#### 2) Is the system to be placed on asphalt?

**Asphalt Installations** - The QUEST CEN System may be installed on asphalt or asphalt overlays. 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. **Use 460 mm [18"] threaded rods, installed with the two part MP-3 grout for these foundations.**

#### 3) Is there a cross slope at the installation site?

**Cross slope exists** - If there is a cross slope of more than 8% (5 deg.), or if the cross slope varies (twists) more than 2% (1 deg.) over the length of the system, a concrete leveling pad may be required. (See Figure 7)

**No Cross slope** - No additional action is required.



*Figure 7*  
*Cross-Slope*

# QUEST® CEN System

## General Maintenance Information

Due to its light weight and minimal number of anchors, the QUEST CEN System is designed for field repair or rapid replacement of the entire system.

Depending upon the severity of the impact and site conditions, the QUEST CEN System can be either refurbished on the roadside or repaired in the maintenance shop away from traffic dangers.

Some of the QUEST CEN System's components remain undamaged after less severe impacts making refurbishment possible. Entire units can be repaired and then reused on the roadside or the damaged portion can be refurbished and reused as needed.

**IMPORTANT: After an impact, always follow the “Post-Impact Instructions” in the maintenance section of the Installation Manual.**

### Recycling Information

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

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

# QUEST® CEN System

## Limitations and Warnings

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

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	<b>Maximum taper/width model - TD80CEN610</b>			
TC 4.2.80	1300	80	15 deg, redirect at L/3	

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