

QuadGuard® Elite® System

GENERAL SPECIFICATIONS

I. GENERAL

All QuadGuard Elite Systems shall be designed and manufactured by Energy Absorption Systems, Incorporated, of Chicago, Illinois.

II. DESCRIPTION OF SYSTEM

A. General

The QuadGuard Elite System shall be a highly reusable crash cushion, easily and quickly restored after a typical design impact. The QuadGuard Elite System shall consist of energy absorbing plastic cylinders surrounded by a framework of steel Quad-Beam™ guardrail that can telescope rearward during head-on impacts. The QuadGuard Elite System shall have a center monorail that will resist lateral movement during side angle impacts and a backup structure that will resist movement during head-on impacts. The nose assembly shall consist of a flexible nose wrap and an energy absorbing plastic cylinder. Transitions from the system to the hazard located behind the system are available and may be required depending on site conditions.

B. Component Description

1. A bay describes a section of the QuadGuard Elite System consisting of an energy absorbing cylinder or bay spacer, a diaphragm, two fender panels and fasteners.
 - a. Except for the first and second bays (closest to the nose), each bay of the QuadGuard Elite System shall be fitted with an energy absorbing plastic cylinder. Double walled cylinders shall be used in all but the front five bays. The cylinders shall be made from polyethylene plastic material conforming to Energy Absorption Systems, Inc. material specifications. Cylinders in successive bays shall be attached to their common diaphragm by passing a wire rope cable around the diaphragm legs and through a steel tube located inside each cylinder. The cable shall be a ½" galvanized wire rope conforming to Energy Absorption Systems, Inc. material specifications.
 - b. The diaphragms shall be made from 10 gauge steel Quad-Beam™ sections. Two support legs shall be welded to the Quad-Beam. Ski-shaped plates

shall be welded to the bottom of the support legs. The diaphragms shall be designed to lock onto and be guided by a ground-mounted, center monorail support structure. Diaphragms shall be available in appropriate widths for the several configurations of the QuadGuard® Elite™ Systems offered.

- c. The fender panels shall be fabricated from 10 gauge steel Quad-Beam sections. The rear of each fender panel (the panel end furthest from the nose of the assembled system) shall be tapered to help maximize performance during wrong-way, redirective impacts. Each fender panel shall be drilled and slotted in accordance with the manufacturer's specifications so that when assembled in the field, the front end (the end closest to the nose of the assembled system) shall be bolted to a diaphragm. The rear of each Quad-Beam fender panel shall overlap the next rearward fender panel and be connected to the diaphragm or the hinge plate of the next bay by means of a bolt and "mushroom" washer. The bolt fits through the long horizontal slot in the forward fender panel. This permits the movement, front to back, of one set of fender panels relative to the panels in the underlying, next rearward bay. The mushroom bolt assembly shall include an elastomeric bushing or a compression spring, which allows limited separation of the fender panels during an impact and offers resisting friction during the restoration phase of an impact event.
2. The monorail support structure shall be made of steel and be anchored, per manufacturers instructions, to a specified rigid surface. The monorail shall prevent lateral movement, vertical movement and overturning of the diaphragms during design impacts.
3. The nose section shall contain a nose cover and an energy absorbing plastic cylinder and is not counted as a bay. The nose cover shall be made from a flexible material formulated to resist damage during impacts. The nose shall attach to the front diaphragm. Standard colors for the nose cover shall be gray or yellow.
4. The backup structure shall be made of steel and be attached to an integral tension strut framework, and shall be available in nominal widths of 610mm (24"), 760mm (30") 915mm (36"), 1.75m (69"), and 2.29m (90").
5. Several transition panels are available as required by site conditions including: Quad-Beam™ to (NJ) Concrete Safety Barrier, Quad-Beam to Thrie-beam, Quad-Beam to W-beam, and Quad-Beam End Shoe (for attachment to vertical concrete walls). Contact Energy Absorption Systems, Inc. for specific applications.

C. Material Specifications

1. Metal work shall be fabricated ASTM A-36 steel. After fabrication, metal work shall be galvanized in accordance with ASTM A-123. All welding shall be done by or under the direction of a certified welder.
2. The system shall be assembled with galvanized fasteners. All bolts, nuts, and washers shall be Commercial Quality "American National Standard" unless otherwise specified.

III. **PERFORMANCE CRITERIA**

A. The QuadGuard® Elite™ System shall perform as a redirective, non-gating crash cushion as specified in the National Cooperative Highway Research Program Report 350, 1993, (NCHRP 350). The system is designed to withstand multiple impacts without requiring replacement of the energy absorbing plastic cylinders.

1. The 11 bay QuadGuard Elite System shall perform as a Test Level 3 (NCHRP 350 TL-3) system. The 11 bay system will be able to withstand multiple impacts without requiring replacement of the cylinders until the rearmost cylinder's minor axis changes from 815 to 660 mm (32" to 26"). It's anticipated that the plastic cylinders will survive in a highway environment for a period ranging from 5 to 15 years from the date of installation.
2. The 7 bay QuadGuard Elite System shall perform as a Test Level 2 (NCHRP 350 TL-2) system. The 7 bay system will be able to withstand multiple impacts without requiring replacement of the cylinders until the rearmost cylinder's minor axis changes from 815 to 660 mm (32" to 26"). It's anticipated that the plastic cylinders will survive in a highway environment for a period ranging from 5 to 15 years from the date of installation.

B. Evaluation Criteria

1. For head-on impacts into the nose, a QuadGuard Elite System shall be specified which is capable of meeting the occupant risk criteria as recommended in NCHRP 350. For vehicles weighing between 820 and 2000 kg [1,810 and 4,410 lb.], the theoretical impact velocity of a hypothetical front seat passenger against the vehicle's interior (calculated from vehicle acceleration and 600mm [24"] forward displacement) shall be less than 12m/s [39.4 ft/sec], and the vehicle's highest 10 millisecond average acceleration subsequent to the instant of the hypothetical passenger impact shall be less than 20 G's.

2. The QuadGuard® Elite™ System shall be capable of redirecting 2000 kg [4,410 lb.] vehicles which impact the sides of the system at speeds up to 100 km/h [62 mph] at angles of 20° for both right-way and wrong-way impacts (angles measured from system's longitudinal centerline). The QuadGuard Elite System shall be capable of redirecting 820 kg [1,810 lb.] vehicles which impact the sides of the system at speeds up to 100 km/h [62 mph] at angles of 15°.
3. The QuadGuard Elite System shall be designed and constructed so there is no solid debris from the system which can create a hazard on the roadway after either head-on or side angle design impacts.

V. DESIGN AND SELECTION CRITERIA

- A. Design, selection and placement of crash cushions shall conform to The American Association of State Highway and Transportation Officials (AASHTO) Publication, "Roadside Design Guide" 1996.
- B. Installation of QuadGuard Elite System attenuators shall be accomplished in accordance with the recommendations of Energy Absorption Systems, Incorporated.