Vulcan® Barrier
Product Description Assembly Manual
The Vulcan® Barrier has been tested pursuant to National Cooperative Highway Research Program (“NCHRP”) Report 350 specifications. The Vulcan® Barrier has been deemed eligible for federal-aid reimbursement on the National Highway System by the Federal Highway Administration (“FHWA”).

Product Description
Assembly Manual

Warning: The local highway authority, distributors, owners, contractors, lessors, and lessees are RESPONSIBLE for the assembly, maintenance, and repair of the Vulcan® Barrier. Failure to fulfill these RESPONSIBILITIES with respect to the assembly, maintenance, and repair of the Vulcan® Barrier could result in serious injury or death.

Important: These instructions are for standard assembly specified by the appropriate highway authority. In the event the specified system assembly, maintenance, or repair would result in a deviation from these assembly instructions, contact the appropriate highway authority engineer.

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

The instructions contained in this manual supersede all previous information and manuals. All information, illustrations, and specifications in this manual are based on the latest Vulcan® Barrier information available to Trinity Highway at the time of printing. We reserve the right to make changes at any time. Please contact Trinity Highway to confirm that you are referring to the most current instructions.
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Customer Service Contacts

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

<table>
<thead>
<tr>
<th>Trinity Highway</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Telephone:</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>E-mail:</strong></td>
</tr>
<tr>
<td><strong>Website:</strong></td>
</tr>
</tbody>
</table>

Important Introductory Notes

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

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

**Important:** DO NOT use any component part that has not been specifically specified herein for the Vulcan® Barrier during assembly or repair.

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

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

This section describes the safety symbols that appear in this Vulcan® Barrier manual. Read the manual for complete safety and assembly information.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Safety Alert Symbol" /></td>
<td><strong>Safety Alert Symbol:</strong> Indicates Danger, Warning, Caution, or Important. Failure to read and follow the Danger, Warning, Safety, or Caution indicators could result in serious injury or death to the workers and/or bystanders.</td>
</tr>
<tr>
<td><img src="image" alt="Important Symbol" /></td>
<td><strong>Important:</strong> Read safety instructions thoroughly and follow the assembly directions and suggested safe practices before assembling, maintaining, or repairing the Vulcan® Barrier.</td>
</tr>
<tr>
<td><img src="image" alt="Warning Symbol" /></td>
<td><strong>Warning:</strong> It is the responsibility of the installer to follow the instructions contained in this manual. Failure to follow this warning could result in increased risk of serious injury or death in the event of a vehicle impact with a system.</td>
</tr>
</tbody>
</table>

Safety Rules for Assembly

* Important Safety Instructions *

This manual must be kept in a location where it is readily available to persons who assemble, maintain, or repair the Vulcan® Barrier. Additional copies of this manual are immediately available from Trinity Highway by calling (888) 323-6374 or by email at product.info@trin.net. Please contact Trinity Highway if you have any questions concerning the information in this manual or about the Vulcan® Barrier.

Always use appropriate safety precautions when operating power equipment and when moving heavy equipment or the Vulcan® Barrier components. Safety articles including but not necessarily limited to work gloves, eye protection, safety-toe shoes, and back support should be used.

| ![Warning Symbol](image) | **Warning:** It is the responsibility of the installer to use all safety measures incorporating traffic control devices specified by the highway authority. These measures must be used to provide safety for personnel while at the assembly, maintenance, or repair site. |
| ![Warning Symbol](image) | **Warning:** Failure to comply with these warnings could result in increased risk of serious injury or death in the event of a vehicle impact with a system that has not been accepted by the FHWA. |
| ![Warning Symbol](image) | **Warning:** Use only Trinity Highway parts on the Vulcan® Barrier for assembly, maintenance, or repair. The use of component parts not specified herein is **strictly prohibited**. The Vulcan® Barrier Assembled with Trinity Highway Parts has been tested, approved, and accepted for state use by the FHWA. A Vulcan® Assembly using parts other than those specified herein has not been tested, approved, or accepted for state use by the FHWA. Failure to follow this warning could result in increased risk of serious injury or death in the event of a vehicle impact. |
Limitations and Warnings

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

The Vulcan® Barrier has been tested and approved by FHWA as meeting the requirements and guidelines of NCHRP Report 350. These tests typically evaluate product performance defined by Report 350 involving a range of vehicles on roadways, from lightweight cars (approx. 1,800 lb. [820 kg]) to full size pickup trucks (approx. 4,400 lb. [2,000 kg]). The Vulcan® Barrier is certified to the Test Level(s) as shown below:

Test Level 2: 1800 lb. [820 kg], 43 mph [70 km/h], 20 degrees
Test Level 3: 4400 lb. [2000 kg], 62 mph [100 km/h], 25 degrees
Test Level 4: 17,600 lb. [8000 kg], 50 mph [80 km/h], 15 degrees

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

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

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

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

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

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

For specific assembly, maintenance, or repair details, refer to the state or specifying agency’s standard drawings and/or Trinity Highway standard layout drawings.

<table>
<thead>
<tr>
<th>System Type(s)</th>
<th>4M</th>
<th>12M</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assembled Length</td>
<td>162” [4.115 m]</td>
<td>463” [11.75 m]</td>
</tr>
<tr>
<td>System Height</td>
<td>32” [813 mm]</td>
<td>32” [813 mm]</td>
</tr>
<tr>
<td>System Width</td>
<td>21 1/2” [546 mm]</td>
<td>21 1/2” [546 mm]</td>
</tr>
<tr>
<td>Weight Per Module</td>
<td>1020 lb [463 kg]</td>
<td>2243 lb [1017 kg]</td>
</tr>
</tbody>
</table>

Recommended Maximum Taper Angle*:
45 mph [70 km/h] 9:1 (6 degrees)
62 mph [100 km/h] 13:1 (4 degrees)

*These values pertain only to TL-1, TL-2 or TL-3 Assemblies, not TL-4.

Figure 1
Vulcan® Barrier Dimensions
Figure 2
Freestanding Configuration

* Max. dynamic deflection = 13'-1" [4.0 m]
NCHRP Report 350 test 3-11
2,000 kg 100 km/h 25 deg.

Taper through clear zone
Recommended Maximum Taper Angle*:
* 70 km/h [45 mph] 9:1 (6 degrees)
* 100 km/h [62 mph] 13:1 (4 degrees)
*Note: These values pertain only to TL-1, TL-2, or TL-3 installations, not TL-4.
Figure 3
End-Anchored Configuration TL-2 / TL-3

---

Refer to Deflection Table

* Max. dynamic deflection = 2'-3" [0.7 m]
  NCHRP Report 350 test 3-21
  2,000 kg 100 km/h 25 deg.

* Max. dynamic deflection = 6'-10" [2.1 m]
  NCHRP Report 350 test 3-11
  2,000 kg 100 km/h 25 deg.
**Refer to page 17 of this manual for the maximum allowable distance between QuadGuard® and anchored end.**

---

**Figure 4**
Anchored Configuration TL-4

*Max. dynamic deflection = 6'-3" [1.9 m]*
EN 1317 TB51 (H2)
13,000 kg 70 km/h 20 deg.

*Note: The end treatments do not meet TL-4 requirements.*
Figure 5
Freestanding w/End Treatment

*Max. dynamic deflection = 13'-1" [4.0 m]
NCHRP Report 350 test 3-11
2,000 kg 100 km/h 25 deg.

* Extra sections are not necessary
if end is anchored after work-zone
(6 Vulcan® Anchor Straps required).
Please refer to Figure 3 on page 8.

Refer to Deflection Table

Option 1
Unidirectional

Option 2

Option 3

**No anchors required on Vulcan® Barrier

6 Vulcan® Anchor Straps Required
(Detail A)
Max. dynamic deflection = 11 3/4” [0.3 m]
NCHRP Report 350 test 3-11 2,000 kg/100 km/h/25 deg.

Figure 6
Limited Deflection Configuration
Length of Need

Length of Need (L.O.N.) is defined as the total length of a longitudinal barrier needed to shield an area of concern. It is also described as that part of a longitudinal barrier or terminal designed to contain and redirect an errant vehicle.

The Beginning of Length of Need (B.L.O.N.) differs depending on how the Vulcan® Barrier is deployed:

- **Example #1** - If the Vulcan® Barrier is deployed as a safety barrier which can be tapered through the clear zone without the need for an approved end terminal, the B.L.O.N. is 312' [95 m] from the beginning of the system.

- **Example #2** - If the Vulcan® Barrier is deployed longitudinally and incorporates the ACZ 350® as an end terminal, the B.L.O.N is 31'-7" [9.6 m] from the beginning of the end terminal.

- **Example #3** - If the Vulcan® Barrier is deployed longitudinally and incorporates an approved redirecting crash cushion as an end terminal, which is anchored to the ground, then the B.L.O.N. is at the very beginning of the approved crash cushion.

- **Example #4** - For TL-4 systems, the only configuration crash tested and accepted to NCHRP Report 350 are straight, longitudinal arrays that are securely anchored to the roadway at both the upstream and downstream ends.

**Warning:** Do NOT modify the Vulcan® Barrier in any way.

**Warning:** It is the sole responsibility of the project engineer and/or local highway authority and its engineer to ensure that the Vulcan® Barrier and delineation used meet all federal, state, specifying agency, and local specifications.

**Warning:** It is the sole responsibility of the project engineer and/or local highway authority and its engineer to ensure that the Vulcan® Barrier meets all appropriate Manual on Uniform Traffic Control Devices (“MUTCD”) and local standards.

**Warning:** It is the sole responsibility of the project engineer and/or local highway authority and its engineer to ensure that there is proper site grading for the Vulcan® Barrier as dictated by the state or specifying agency, pursuant to FHWA acceptance.
End Treatment

A terminal as defined by the FHWA for NCHRP Report 350:

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 Vulcan® Barrier has been crash tested to NCHRP Report 350 as a Test Level 3 (TL-3 100 km/h [62 mph]) and TL-4 redirective longitudinal barrier and accepted by FHWA, and when deployed and tapered through the clear zone, does not require a separate end treatment.

If the site specific conditions require a longitudinal barrier and won’t allow tapering of the end, the following fully tested end terminals may be considered by the appropriate highway authority:

- The TL-3 Triton VET or the ACZ 350 are accepted for speeds up to 100 km/h [62 mph]. As the Vulcan® Barrier design is based on the Triton Barrier® profile, Triton Barrier® will pin directly to the VET transition hardware. Refer to the standard drawings contained in this manual for specific detail.

- An anchored, redirective crash cushion is accepted for posted speeds up to TL-3 100 km/h [62 mph] and offers the shortest Vulcan® Barrier deployment. Anchored, redirective crash cushions are suitable for use where the length of need occurs at or near the beginning of the terminal.

Should the nature of the site not provide adequate area for a clear zone, the Vulcan® Barrier when deployed longitudinally may also be shielded by using a geometric array of Energite sand barrels. Refer to the Energite Manual for specific detail of the array required for the speed zone in which the device will be placed.

The Vulcan Barrier has also been crash tested to TL-4 standards and meets the European and FHWA TL-4 criteria for longitudinal barriers. However, if using an end terminal, remember that the end terminals do not meet TL-4 criteria.

Deflection

The TL-3 results for the 2000P at 25 degrees are taken directly from NCHRP Report 350 test results and represent the maximum dynamic deflection experienced. Deflections are shown for smaller impact angles and for lower test speeds. **No actual test for this vehicle mass and impact angle was carried out on this system.**

Dynamic deflection represents the maximum amount of lateral movement of the system. Testing has confirmed that the permanent static deflection is approximately 10% less than the dynamic deflection. Actual deflections may vary from expected values due to site conditions.

For TL-4 applications the only configuration crash tested and accepted to NCHRP Report 350 is an array that is securely anchored to the ground at both end points. A maximum permanent deflection of 6.5’ [1.97 m] is expected when impacted by an 17,637 lb [8,000 kg] vehicle traveling at 80 km/h [50 mph] 15 degrees from parallel or a 28,660 lb [13,000 kg] bus at 44 mph [70 km/h] at 20 degrees from parallel.
### Vulcan® Barrier Deflection Charts

#### 4400 lb. Pick-Up Truck Test – Anchored at Both Ends

<table>
<thead>
<tr>
<th>Impact Angle</th>
<th>5 Degrees</th>
<th>10 Degrees</th>
<th>15 Degrees</th>
<th>20 Degrees</th>
<th>25 Degrees</th>
<th>NCHRP Report 350 Test Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 mph</td>
<td>0.05</td>
<td>0.18</td>
<td>0.41</td>
<td>0.71</td>
<td>1.09</td>
<td>NA</td>
</tr>
<tr>
<td>31 mph</td>
<td>0.07</td>
<td>0.29</td>
<td>0.64</td>
<td>1.12</td>
<td>1.71</td>
<td>NA</td>
</tr>
<tr>
<td>37 mph</td>
<td>0.10</td>
<td>0.42</td>
<td>0.92</td>
<td>1.61</td>
<td>2.46</td>
<td>NA</td>
</tr>
<tr>
<td>43 mph</td>
<td>0.14</td>
<td>0.56</td>
<td>1.25</td>
<td>2.17</td>
<td>3.32</td>
<td>TL-2</td>
</tr>
<tr>
<td>50 mph</td>
<td>0.18</td>
<td>0.74</td>
<td>1.63</td>
<td>2.84</td>
<td>4.35</td>
<td>NA</td>
</tr>
<tr>
<td>55 mph</td>
<td>0.23</td>
<td>0.93</td>
<td>2.07</td>
<td>3.61</td>
<td>5.52</td>
<td>NA</td>
</tr>
<tr>
<td>62 mph</td>
<td>0.29</td>
<td>1.15</td>
<td>2.56</td>
<td>4.46</td>
<td>6.82</td>
<td>TL-3</td>
</tr>
<tr>
<td>68 mph</td>
<td>0.35</td>
<td>1.40</td>
<td>3.10</td>
<td>5.41</td>
<td>8.27</td>
<td>NA</td>
</tr>
</tbody>
</table>

#### 4400 lb. Pick-Up Truck Test – Freestanding

<table>
<thead>
<tr>
<th>Impact Angle</th>
<th>5 Degrees</th>
<th>10 Degrees</th>
<th>15 Degrees</th>
<th>20 Degrees</th>
<th>25 Degrees</th>
<th>NCHRP Report 350 Test Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 mph</td>
<td>0.09</td>
<td>0.35</td>
<td>0.79</td>
<td>1.37</td>
<td>2.10</td>
<td>NA</td>
</tr>
<tr>
<td>31 mph</td>
<td>0.14</td>
<td>0.56</td>
<td>1.23</td>
<td>2.15</td>
<td>3.29</td>
<td>NA</td>
</tr>
<tr>
<td>37 mph</td>
<td>0.20</td>
<td>0.80</td>
<td>1.78</td>
<td>3.10</td>
<td>4.74</td>
<td>NA</td>
</tr>
<tr>
<td>43 mph</td>
<td>0.27</td>
<td>1.08</td>
<td>2.40</td>
<td>4.19</td>
<td>6.40</td>
<td>TL-2</td>
</tr>
<tr>
<td>50 mph</td>
<td>0.36</td>
<td>1.42</td>
<td>3.14</td>
<td>5.48</td>
<td>8.38</td>
<td>NA</td>
</tr>
<tr>
<td>55 mph</td>
<td>0.45</td>
<td>1.80</td>
<td>3.99</td>
<td>6.95</td>
<td>10.63</td>
<td>NA</td>
</tr>
<tr>
<td>62 mph</td>
<td>0.56</td>
<td>2.22</td>
<td>4.93</td>
<td>8.59</td>
<td>13.15</td>
<td>TL-3</td>
</tr>
<tr>
<td>68 mph</td>
<td>0.68</td>
<td>2.70</td>
<td>5.97</td>
<td>10.41</td>
<td>15.93</td>
<td>NA</td>
</tr>
</tbody>
</table>

#### 4400 lb. Pick-Up Truck Test – Vulcan® Gate

Deflection is 1.3’ for the 25° impact at 62 mph (TL-3).

**Note:** Deflection will be less than 1.3 feet for impacts at less than 25° and below speeds of 62 mph.

#### 4400 lb. Pick-Up Truck Test – Anchored Every Vulcan® Gate Section

Deflection is 3” at the base for the 25° impact at 62 mph (TL-3).

**Note:** Deflection will will vary from 0 to 3” for impacts at less than 25° and below speeds of 62 mph.

Slope is Measured Deflection divided by Actual IS of test. Calculation based on a linear relationship between impact severity (IS) and deflection. Formula for calculations are taken from CEN Standards document EN-1317 using the equation for Normalized Dynamic Deflection (DN).
Other Considerations

A variety of conditions may affect the ultimate performance for the Vulcan® Barrier. Since every job site is unique, the highway designer and/or the appropriate highway authority needs to consider the following conditions when incorporating the Vulcan® Barrier in the Design.

Curves

The ends of each section are constructed with knuckles that interlock with those of other adjacent segments. The end knuckles are vertically aligned to accept a steel connecting pin. The pin securely joins the sections for maximum impact performance. The sections can swivel up to 6° at the pin for easy positioning around work areas for the following road contours (Figure 7).

Slopes

Cross-Slopes

The Vulcan® Barrier may be placed on cross-slopes up to 5% (3°) (Figure 8).

Longitudinal Slopes

The Vulcan® Barrier may be placed on longitudinal slopes up to 5% (3°) (Figure 9).
Curbs
The Vulcan® Barrier MUST NOT be placed directly against curbs that can prevent its lateral movement (Figure 10).

Trenches
The Vulcan® Barrier MUST NOT be placed near trenches or excavations where in the event of an impact, the deflection of the system may result in barrier failure.

Note: Safe working deflection distances are detailed in the Deflection Charts on page 14.

Caution: The existence of any cross-slopes in excess of 5% (3°) or curbs may create an untested effect on the impacting vehicle.
Unidirectional Traffic and Median Applications

This alternate downstream anchoring option can only be used where the possibility of a reverse direction impact into the system is not possible.

The Anchor Straps are suitable for use with 4M and 12M Vulcan® Barrier segments. Six Vulcan® Anchor Straps are recommended for this application. These are positioned against the last six bulkheads using the anchoring guidelines in this Manual. Bidirectional transitions are also available.

**Warning:** When using Vulcan® Barrier with a QuadGuard CZ as an end terminal, ensure the QuadGuard® anchors are tight before attaching the Vulcan® Barrier.

---

Figure 11
Unidirectional Traffic and Median Applications – QuadGuard CZ
Assembly

Preparation

Begin preparing for the assembly by thoroughly reviewing the specified barrier location, layout, and orientation as per the approved traffic management plan.

Determine the number of segments required for assembly. The length of each Vulcan® Barrier segment, when assembled, is 13'-6" [4 m]. Consideration must be given to determine if an end treatment is required and allow for the length of the treatment when determining required segments and overall system length.

**Important:** A visual inspection should be carried out to confirm the suitability of all segments. Should visible damage be evident in any segments, they should be returned and replaced prior to assembly.

Recommended Tools

1. Vulcan® Barrier Product Description Assembly Manual
2. Traffic control plan and approval (as required)
3. Traffic control equipment (as required)
4. A truck-mounted crane or forklift suitable for a minimum lift of 1020 lb. [460 kg] for 4M sections or 2243 lb. [1017 kg] for 12M sections and appropriate slinging gear. The Vulcan® Barrier is designed to stack up to three (3) segments in height so provision must be made to lift from a height of 7'-10 1/2" [2.4 m] plus the tray height.

Deployment

1. Begin deployment at the upstream traffic end of the site and work downstream. Work from the non-traffic side of the assembly whenever possible. Unloading proceeds much faster if one person remains on the truck and two people work on the ground. If site conditions permit, a fourth person can drive the truck so that the segments can be unloaded continuously as the job progresses.
2. Align the segments according to the specified configuration and layout in the traffic control plan.

**Warning:** It is the responsibility of the installer to ensure that all safety measures incorporating appropriate traffic control devices specified by the highway authority are used to protect all personnel at the assembly, maintenance, or repair site.

**Warning:** When using Vulcan® Barrier with an approved end terminal, be sure the anchors are tight before attaching the Vulcan® Barrier.

**Caution:** Refer to the Deflection Chart on page 14 when determining minimum clearance between barrier and roadside obstacle.
3. Bring the segments together and insert a connecting pin through the spacer* then through the overlapping end knuckles at each joint. Push the pin in until it is flush with the top of the segments.

*Spacers (PN 614555B) are used to minimize joint rotation. Trinity Highway recommends inserting spacers for optimum performance and minimum lateral deflection.

![Figure 12](image)

4. Vulcan® Barrier(s) can be lifted pre-assembled to decrease placement time.

![Figure 13](image)
5. Vulcan® Barrier(s) can also be moved with a host vehicle.

**Warning:** It is the responsibility of the installer to ensure that the host vehicle has the capacity to tow the Vulcan® Assembly.

**Towing**

- **Do not** tow more than 131’ 1” [40 m] at a time.
- Make sure jacks are deployed before moving barrier.
- **Do not** exceed 3 mph.
- Make sure adequate personnel are available to prevent lateral movement of barrier when cross-slope is present.
- Ensure barrier(s) are properly secured prior to disconnecting from host vehicle.

![Figure 14](image)

**Caution:** When deploying the Vulcan® Barrier, care must be taken not to exceed the maximum recommended taper angle as detailed on page 7.

6. If an end treatment is specified for the layout, follow the instructions provided by the manufacturer and attach at this time.

**Caution:** An end treatment accepted by FHWA, under the appropriate criteria, must be supplied where warranted to ensure accepted crash performance.

7. Deployment is now complete. Take a moment to confirm system integrity and functionality.

**Retrieval**

Retrieval is a reverse of the instructions for deployment.

**Inspection**

A visual inspection of each barrier segment is required prior to shipping.

The Vulcan® Barrier system is modular by design that is essentially made up of eleven main components, which can all be replaced, thus ensuring a long service life.

Barrier segments which show evidence of prior impact should be thoroughly inspected for any sign of distortion or disfigurement. All distorted or disfigured segments must be refurbished or replaced prior to use.
Anchoring Instructions

Recommended Tools

- Vulcan® Barrier Manual
- Transport truck
- Sledge hammer
- Pry bar
- Generator (power for optional accessories)
- A truck-mounted crane or forklift suited to a minimum 900 lb. [400 kg] lift and appropriate slinging gear
- 7/8” Concrete drill bits (*Double Fluted)
- Grinder, hacksaw, or torch (optional)
- Trinity Highway recommends using double fluted drill bits to achieve optimum tensile strength when mounting with an approved adhesive anchoring system.
- Rotary hammer drill
- Heavy duty impact wrench
- Adjustable wrench 24”
- 1/2” drive sockets: 1 1/4”
- Ratchet and attachments for the above sockets
- Breaker bar: 1/2” x 24”
- Torque wrench: 200 ft-lb [270 Nm]
- Impact wrench: 1/2” drive
- Lubrication - WD40
- This Product Manual and Manufacturer’s print package
- Applicable location, layout, orientation, and construction plans
- Eye protection
- Safety-toe shoes
- Gloves
- Protective clothing
- Traffic control equipment (as required)

Note: The above list of tools is a general recommendation and should not be considered an extensive list. Depending on specific site conditions and the complexity of the assembly specified by the appropriate highway authority, the required tools may vary. Decisions as to what tools are needed to perform the job are entirely the responsibility of the specifying highway authority and the authority’s selected contractor performing the assembly of the system at the authority’s specified assembly site.
Anchored Vulcan® Foundations

The Vulcan® Barrier may be installed on any of the following foundations using the specified anchorage:

**Foundation A: Concrete Pad or Roadway**
Foundation: 6" [150 mm] minimum depth Portland Cement Concrete (P.C.C.)
Anchorage: Approved adhesive with 7" [180 mm] studs 5 3/4" [146 mm] embedment

**Foundation B: Asphalt over P.C.C.**
Foundation: 3" [76 mm] minimum asphalt concrete (A.C.) over 3" [76 mm] minimum P.C.C.
Anchorage: Length of anchor required is 460 mm [18"] 425 mm [16 3/4"] embedment

**Foundation C: Asphalt over Subbase**
Foundation: 6" [150 mm] minimum A.C. over 6" [150 mm] minimum Compacted Subbase (C.S.)
Anchorage: Approved adhesive with 18" [460 mm] studs 16 3/4" [425 mm] embedment

**Foundation D: Asphalt Only**
Foundation: 8" [200 mm] minimum A.C.
Anchorage: Approved adhesive with 18" [460 mm] studs - 16 3/4" [425 mm] embedment

**Foundation Specifications**
for Foundations A, B, C and D mentioned above:

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

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

**P.C.C. (Portland Cement Concrete)**
Stone aggregate concrete mix
4000 psi minimum compressive strength
(Sampling per ASTM C31-84 or ASTM C42-84a, testing per ASTM C39-84)

**C.S. (Compacted Subbase)**
6" [150 mm] minimum depth 95% compaction
Class 2 aggregate
Position the Vulcan® Barrier sections.
Locate Anchor Straps at panel connection points as shown in Figure 15 when anchoring each barrier section.
Use the Anchor Straps as templates to drill anchor holes. Refer to Figure 16 and the approved adhesive instructions contained in the kit supplied with the system.

Figure 15 - Anchor Strap Locations

Figure 16 - Anchoring the System

Materials:

A. Asphaltic Concrete (per ASTM D3381)
   Asphalt Binder AR-4000

B. 4000 PSI [28 MPa] P.C. Concrete (Sampling per ASTM C31 or ASTM C42, testing per ASTM C39)

C. Subbase, prepared and compacted
   Class 2 Aggregate
   95% compaction, minimum layer
Trinity Highway Approved Adhesive Anchoring System

A Trinity Highway approved adhesive anchoring system is required to securely anchor longitudinal barriers. Each approved adhesive kit contains adhesive, studs, nuts and washers. Both vertical and horizontal assemblies are possible using an approved adhesive anchoring system.

Vertical Assemblies

Note: Read all Trinity Highway approved adhesive instructions before starting.

1) Prepare the Concrete Foundation

   Warning: Do not allow anchoring adhesive to contact skin or eyes. See safety data sheet supplied with adhesive kit for first-aid procedures. Use only in well-ventilated area. Do not use near open flame.

   Warning: Wear gloves and eye protection during application.

   The anchor bolts (studs) that anchor the Vulcan® Barrier Backup to the concrete foundation must be those shipped in the kit or of high strength steel (830 MPa [120,000 psi] minimum tensile strength or equal). These studs must be set in minimum 28 MPa [4000 psi] concrete. Allow the concrete to cure a minimum of seven days before applying anchoring adhesive.

2) Drill Boreholes

   Caution: It is the responsibility of the installer to consult OSHA silica respiratory standard 29 CFR 1910.134 for debris removal from borehole(s) and use Trinity Highway approved adhesive to achieve optimum tensile strength. Do not use diamond drill bits for drilling boreholes.

   Use the Monorail(s) and Tension Strut Backup as drilling templates. Use a rotary hammer drill to drill the boreholes 7/8" [22 mm] diameter to the recommended depth. See the approved adhesive instructions provided with adhesive kit. Check to ensure each borehole is drilled to the proper depth and aligned with the part to be anchored.

<table>
<thead>
<tr>
<th>Stud Size</th>
<th>Orientation</th>
<th>Concrete Bit Size</th>
<th>Minimum Depth</th>
<th>Recommended Torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4&quot; x 6 1/2&quot;</td>
<td>Horizontal</td>
<td>7/8&quot; [22 mm]</td>
<td>5 1/4&quot; [133 mm]</td>
<td>Manufacturer Spec</td>
</tr>
<tr>
<td>3/4&quot; x 7&quot;</td>
<td>Vertical</td>
<td>7/8&quot; [22 mm]</td>
<td>5 3/4&quot; [146 mm]</td>
<td>Manufacturer Spec</td>
</tr>
<tr>
<td>3/4&quot; x 18&quot;</td>
<td>Vertical</td>
<td>7/8&quot; [22 mm]</td>
<td>16 3/4&quot; [425 mm]</td>
<td>10 ft-lb [15 N-m]</td>
</tr>
</tbody>
</table>

Important: When mounting on asphalt, initial torque shall be as shown in Anchoring Information. Due to the properties of asphalt, anchors may loosen over time. For this reason Trinity Highway recommends anchoring to asphalt only at temporary locations. It is the responsibility of the installers to retorque anchors in asphalt every six (6) months to the proper initial torque specified.
3) **Clean the Boreholes**

Blow the concrete dust from the borehole using oil-free compressed air. Thoroughly brush it with a 7/8” diameter steel bristle tube brush and then blow it out again. If the borehole is wet, completely flush it with water while brushing and then blow it clean to remove all water using oil-free compressed air.

4) **Apply Approved Adhesive**

Fill the borehole 100% full.

Caution: Fill borehole 100% full so it is even with the pavement surface per manufacturer’s instructions.

5) **Add Nuts to Anchor Studs**

Place a flat washer onto the stud then thread a nut on until the end of the stud is flush with the NUT (Figure 17).

6) **Insert Studs in Boreholes and Wait for Adhesive to Cure**

Push the stud down through the part to be anchored and into the borehole. Give the stud several twists in the approved adhesive to wet the threads.

Caution: Do not disturb or load the stud until the approved adhesive material has hardened (see instructions supplied with the approved adhesive kit).

7) **Torque the Nuts**

Once the adhesive has fully cured, torque the nut to the adhesive manufacturer’s recommended values.

---

**Anchor Assembly Cautions**

1) **Steel rebar**

If steel rebar is encountered while drilling an anchor bolt borehole, apply one of the following solutions:

A) Use a rebar drill bit for the **rebar only** and then switch back to the concrete bit to finish drilling into the underlying concrete until the proper borehole depth is reached.

Caution: Do not drill through rebar without first obtaining permission to do so from the project engineer.

B) Drill a new borehole down at an angle past the rebar to the proper depth. Anchor the stud by completely filling both boreholes with an approved adhesive.
Horizontal Assemblies
The horizontal approved adhesive kit is the same as the vertical kit.

**Caution:** Fill borehole 100% full so it is even with the surface of the hole per manufacturer’s instructions.

1) **Follow the instructions supplied with your approved adhesive kit**
   Apply approved adhesive to each anchor per instructions.

2) **Add the Washers and Nuts**
   Put washer and nut on stud so the nut is flush with end of stud.

3) **Insert each Stud with Washer and Nut into Borehole**
   Push stud with washer and nut into borehole. Twist the stud in the approved adhesive to fully wet the threads.

   **Important:** The stud should be flush with the top of the nut in both **vertical** and **horizontal** applications prior to tightening (Figure 18).

   ![CORRECT](image)

   ![INCORRECT](image)

   **Figure 18**
   Horizontal Application (Before Applied Torque)

**Warning:** Do not disturb or load the stud until the approved adhesive material has hardened (see approved adhesive kit instructions for cure times and torque values).

4) **Torque the nuts**
   Once the adhesive has fully cured, torque nut(s) to the approved adhesive manufacturing specification.
Inspection Notice for Permanent Applications on Asphalt

Trinity Highway recommends that the system be inspected by qualified personnel according to the guidelines set forth in the Maintenance and Repair section with the following additions:

1. Deploy the appropriate traffic control devices to protect your crew.

   **Warning:** The correct safety equipment and approved traffic management must be used as required for Walk-Up Inspections of the Vulcan® Barrier system.

2. Increase the frequency of Walk-Up Inspections to once every six months (instead of once every 12 months for concrete applications).

3. Check to see that all anchor bolts have remained firmly anchored in the roadway surface and in the Concrete Backup, if applicable. Replace any anchors that are loose, broken, or pulled out.

   **Important:** If the system is anchored to asphalt, up to 10% of the total anchors may be replaced if damaged. If more than 10% of the anchors are damaged the system should be relocated to fresh, undisturbed asphalt and redeployed using 18” [460 mm] threaded rods.

   **Warning:** Use only Trinity Highway parts on the Vulcan® Barrier for assembly, maintenance, or repair. The use of component parts not specified herein is strictly prohibited. The Vulcan® Barrier Assembled with Trinity Highway Parts has been tested, approved, and accepted for state use by the FHWA. A Vulcan® Assembly using parts other than those specified herein has not been tested, approved, or accepted for state use by the FHWA. Failure to follow this warning could result in increased risk of serious injury or death in the event of a vehicle impact.
Final Inspection Checklist
Inspection Date: _______________________

Inspected By: __________________________

Verify that the proper transitions are in place and are properly fitted.
Make sure all transitions and anchor straps have an anchor in each hole.
Check torque on anchors to make sure they are properly torqued.
Check to make sure all connecting pins are properly inserted between each barrier.
Check all hardware to make sure it’s tight and has not loosened during shipment.
Make sure system is clear of construction debris.
If barrier has Jacks make sure jacks are not in contact with the surface of the road when barrier is deployed.

Copy this sheet for each inspection.
System Components
Below is the list of required system components and quantities.

Note: The components are not shown to scale.

ITEM 1
616160G
Vulcan® Transition to ACZ-350®
Assembly Drawing 616080B

ITEM 2
616138B
Vulcan® Transition to Bidirectional QuadGuard®
Assembly Drawing 616100

ITEM 3
616197B
Vulcan® Transition to Unidirectional Quest®
Assembly Drawing 603501B

ITEM 4
616189B
Vulcan® Transition to Triton Barrier®
Assembly Drawing 616244 / 616245
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<th>616958B</th>
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<tr>
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<tr>
<td>Assembly Drawing 616029</td>
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<tr>
<td>Vulcan® Transition to Bidirectional QUEST®</td>
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<td>Assembly Drawing 617509</td>
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<table>
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<th>ITEM 8</th>
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<tr>
<td>Vulcan® Transition to Bidirectional TRACC®</td>
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<tr>
<td>Assembly Drawing 618727</td>
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## PARTS LIST

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<tr>
<td>1</td>
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<td>TRANSITION ASSY, WELDMENT QUAD-VULCAN, HIGH CAPACITY</td>
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<td>2</td>
<td>679021-0000</td>
<td>BOLTS, THREAD 3/8-16-05G</td>
<td>12</td>
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<tr>
<td>3</td>
<td>3525220-0000</td>
<td>ANCHOR MP-3, QUART KIT NO STUCCO</td>
<td>3</td>
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<tr>
<td>4</td>
<td>279007-0000</td>
<td>SPACER, VULCAN TRANSISTORS &amp; NIGHTE</td>
<td>1</td>
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<tr>
<td>5</td>
<td>679020-0000</td>
<td>PIN, CONNECTING VULCAN</td>
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### VULCAN TRANSITION SECTION VIEW

**SCALE 1:20**

**MATERIALS:**
- A: ASPHALT/C. CONCRETE (PER ASTM C3361)
- ASPHALT BINDER OR A 500
- ASPHALT AGGREGATE 1/2" (12.7mm) MIXED MED A B
- 28 MPa [400 psi] P.C. CONCRETE, SAMPLED PER ASTM C31-04 OR ASSTM C61-04,
- TESTING PER ASTM C39-86
- C: SUB BASE, PREPARED AND COMPACTED CLASS 2 AGGREGATE
- 95% COMPACTION, MINIMUM LAYER.

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
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<tr>
<td>110mm</td>
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<tr>
<td>65mm</td>
<td>50mm</td>
<td>400mm (16&quot;)</td>
</tr>
<tr>
<td>50mm</td>
<td>50mm</td>
<td>400mm (16&quot;)</td>
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</table>

**ASSEMBLY NO.** 3586004-0000

ENERGY ABSORPTION SYSTEMS, INC.
ENGINEERING AND RESEARCH DEPARTMENT

TRANSITION ASSY, QUAD-VULCAN

**Signature:** 6/3/2015

TRANSITION ASSY, QUAD-VULCAN

**Revision E**

6/16/2019

**NOTES:**
1. REMOVE SIDE PANELS ON BACK UP BEFORE INSTALLING.
2. ANCHOR USING ONE OF THE FOLLOWING:
   - "T" STUDS MAY BE USED TO ATTACH TO 28 MPa [400 psi] P.C.
   - 110mm [4.36"] CONCRETE RAMPWAY 177mm [7"] DECK STRUCTURE, RIVETS INCLUDED.
   - 18" THREADED ROD FOR ASPHALT INSTALLATIONS.

**Design:** B. Pakas, Jr. 1/13/2006
**Drawn By:** K. Cooney 6/31/2015

Reference: 3586004-0000.dwg

**Conversion:** 1:25

**Scale:** 3586004-0000 1 of 1
ADAPTER KIT, VULCAN®-QUEST® UNIDIRECTIONAL
### PARTS LIST

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<th>DESCRIPTION</th>
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<tr>
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<td>004084W</td>
<td>BACKUP NEAT TO VULCAN, PT</td>
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</tr>
<tr>
<td>2</td>
<td>011170W</td>
<td>TRANSITION NEAT TO VULCAN RIGHT, PT</td>
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<tr>
<td>3</td>
<td>016616W</td>
<td>TRANSITION NEAT TO VULCAN LEFT, PT</td>
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<tr>
<td>4</td>
<td>010221Y</td>
<td>PIN - 30-1/2, NEAT</td>
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<tr>
<td>5</td>
<td>003502D</td>
<td>BOLT, RAIL, 3/8 X 1-3/4</td>
<td>8</td>
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<tr>
<td>6</td>
<td>003402D</td>
<td>NUT, HI, 3/8 O, RAIL</td>
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<td>7</td>
<td>11202000B</td>
<td>INSTRUCTION, VULCAN TO N-E-A-T TRANSITION</td>
<td>1</td>
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</tbody>
</table>

### NOTE 1
1. ATTACH THE BACKUP (ITEM 1) TO THE NEAT WITH 1/2" NUT, LOCK AND FLAT WASHER.
2. PIN (ITEM 4) THE RIGHT AND LEFT TRANSITION (ITEMS 2 & 3) TO THE BACKUP (ITEM 1).
3. POSITION THE BACKUP (ITEM 1) WITH THE VULCAN BARRIER AND INSTALL THE VULCAN PIN.
4. USING THE RIGHT AND LEFT TRANSITION (ITEMS 2 & 3) AS A TEMPLATE, FIELD DRILL EIGHT 22 mm [?/?] HOLES.
5. ATTACH THE RIGHT AND LEFT TRANSITIONS (ITEMS 2 & 3) TO THE VULCAN BARRIER WITH RAIL SLOTS AND NUTS (ITEMS 5 & 6).

### ASSEMBLY NO. 516958B

<table>
<thead>
<tr>
<th>NAME</th>
<th>DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>D. Kohl</td>
<td>9/6/2007</td>
</tr>
<tr>
<td>A. Cox</td>
<td>9/5/2007</td>
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<tr>
<td>J. Miller</td>
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**VULCAN® TO N-E-A-T® TRANSITION**
TRANSITION ASSEMBLY, VULCAN®-PCMB
VULCAN® ANCHOR KIT, GATING TERMINAL, ASPHALT