



U.S. Department  
of Transportation  
**Federal Highway  
Administration**

400 Seventh St., S.W.  
Washington, D.C. 20590

November 17, 2005

In Reply Refer To: HSA-10/B-134A

Mr. Barry D. Stephens, P.E.  
Sr. Vice President Engineering  
Energy Absorption Systems, Incorporated  
3617 Cincinnati Avenue  
Rocklin, California 95765

Dear Mr. Stephens:

In my February 14 acceptance letter (HSA-10/B-134) for the Vulcan Barrier, I noted that additional information would be needed before the Vulcan could be deemed crashworthy and acceptable for use in bidirectional applications when connected to a rigid crash cushion or concrete barrier. Staff members had expressed concern about potential pocketing and/or snagging of vehicles impacting the freestanding Vulcan units immediately downstream from a rigid connection point.

In late September, you provided members of my staff data from a reverse direction crash test you ran to address the above concern. The tested transition was designed to connect freestanding Vulcan Barrier units to an anchored QuadGuard CZ. The test results for the National Cooperative Highway Research Program (NCHRP) Report 350, Test 3-21 were supplied with your transmittal in the form of a crash test video, a 1-page test summary (Enclosure 1), and before/after photographs. The transition design consisted of a galvanized steel weldment measuring 2.03-m long, 0.8-m high and a variable width that matches the Vulcan Barrier shape to a .61-m wide QuadGuard CZ System (Enclosure 2). The transition incorporates a lower steel mounting plate measuring 9.5-mm thick x 1.07-m wide x 1.22-m long with twelve (12) mounting holes for anchoring the transition to a rigid foundation. For this crash test, four (4) unanchored Vulcan segments were pinned together and the upstream end was pinned to an anchored QuadGuard backup to provide tension to the unanchored Vulcan segments. The downstream end of the unanchored Vulcan was attached to the new transition that was, in turn, attached to a 6-bay, .61-m wide QuadGuard CZ backup. The targeted impact point was the connection between the unanchored Vulcan segment and the new transition. The 2000P vehicle was contained and redirected and the reported occupant risk values were considered acceptable. However, there remained some concern that field installations would be far longer than the test installation, resulting in greater barrier deflection and consequently, more pocketing in the transition area.



To mitigate our concern about pocketing, you submitted with your November 8 letter, a modified Vulcan design that incorporates additional anchoring on the impact side of the three Vulcan sections immediately upstream from the transition (Enclosure 3). Your design gradually increases the number of anchors per section on the approach to the transition. This increase in anchors provides gradual stiffening similar to that which has been successfully tested with precast concrete barrier segments connected to a rigid concrete bridge railing.

Based upon the submitted test results and your Vulcan anchoring improvement, I agree that the proposed transition between Vulcan Barrier and anchored QuadGuard CZ Systems meets the NCHRP Report 350 TL-3 evaluation criteria and may be used on the National Highway System as a transition between these devices in bidirectional applications. I also agree that the results of the submitted test and the addition of anchors to the Vulcan units adjacent to the barrier support the acceptance of your transition between Vulcan and Concrete Median Barrier (CMB) when the Vulcan-to-CMB transition piece (Enclosure 4) is used.

Please note also that the standard provisions for the Federal Highway Administration letters of acceptance noted on my original Vulcan acceptance letter remain applicable to this transition design.

Sincerely yours,

*/original signed by George Ed Rice, Jr./*

*~for~*

John R. Baxter, P.E.  
Director, Office of Safety Design  
Office of Safety

4 Enclosures



t = 0.000 sec



t = 0.090 sec



t = 0.180 sec



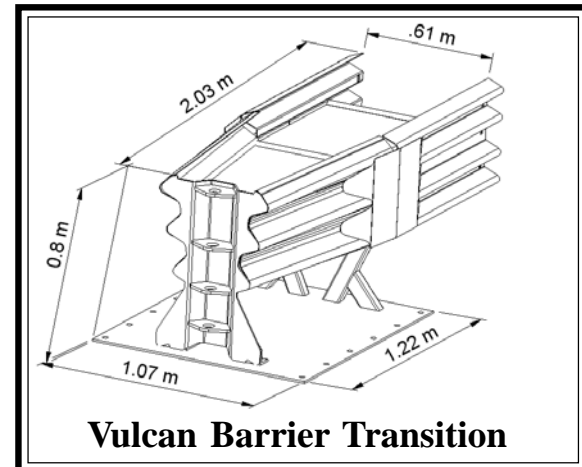
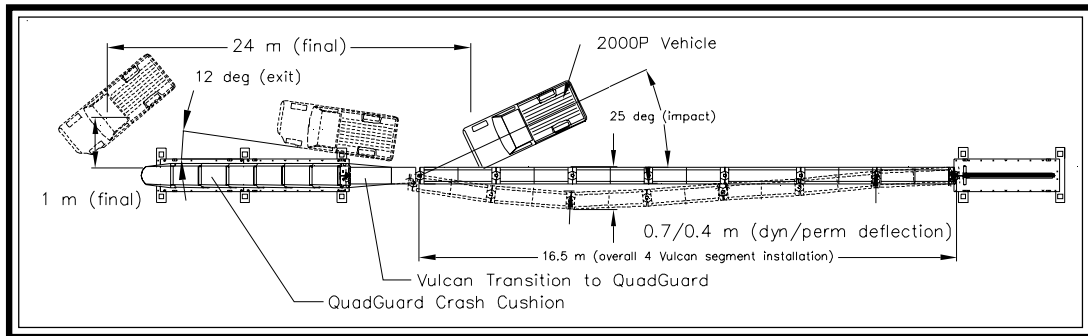
t = 0.270 sec



t = 0.360 sec



t = 0.450 sec



**Vulcan Barrier Transition**

**General Information**

Test Agency .....	E-TECH Testing Services, Inc.
Test Designation .....	NCHRP 350 Test 3-21
Test No. ....	01-8430-004
Date .....	8/29/05
<b>Test Article</b>	
Type .....	Vulcan™ Barrier Transition
.....	to QuadGuard QZ2406Y Crash
.....	Cushion, Transition 2030 mm x
.....	800 mm x 610 mm (L x H x W)
Installation Length .....	(4) Vulcan segments 16.5 m overall
.....	length w/o Transition and Crash
.....	Cushion end anchorage
Material and key elements .....	AASHTO M180 galvanized steel
.....	panels, ASTM A53 Pins, and A36
.....	other
Foundation Type and Anchorage .....	Concrete, (12) 19 mm x 165 mm
.....	ASTM A193 B7 studs, MP-3
.....	Anchoring System
<b>Test Vehicle</b>	
Type .....	Production Model
Designation .....	2000P
Model .....	1989 Chevrolet C2500 Pickup
Mass (kg)	
Curb .....	1988
Test inertial .....	1989
Dummy .....	N/A
Gross .....	1989
<b>Impact Conditions</b>	
Speed (km/h) .....	99.7
Angle (deg) .....	25
Impact Severity (kJ) .....	136.1

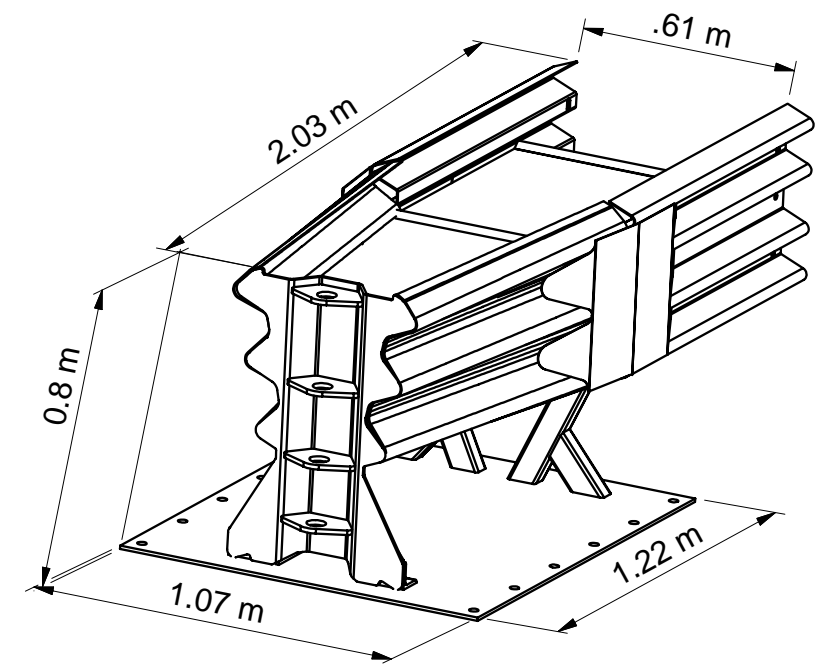
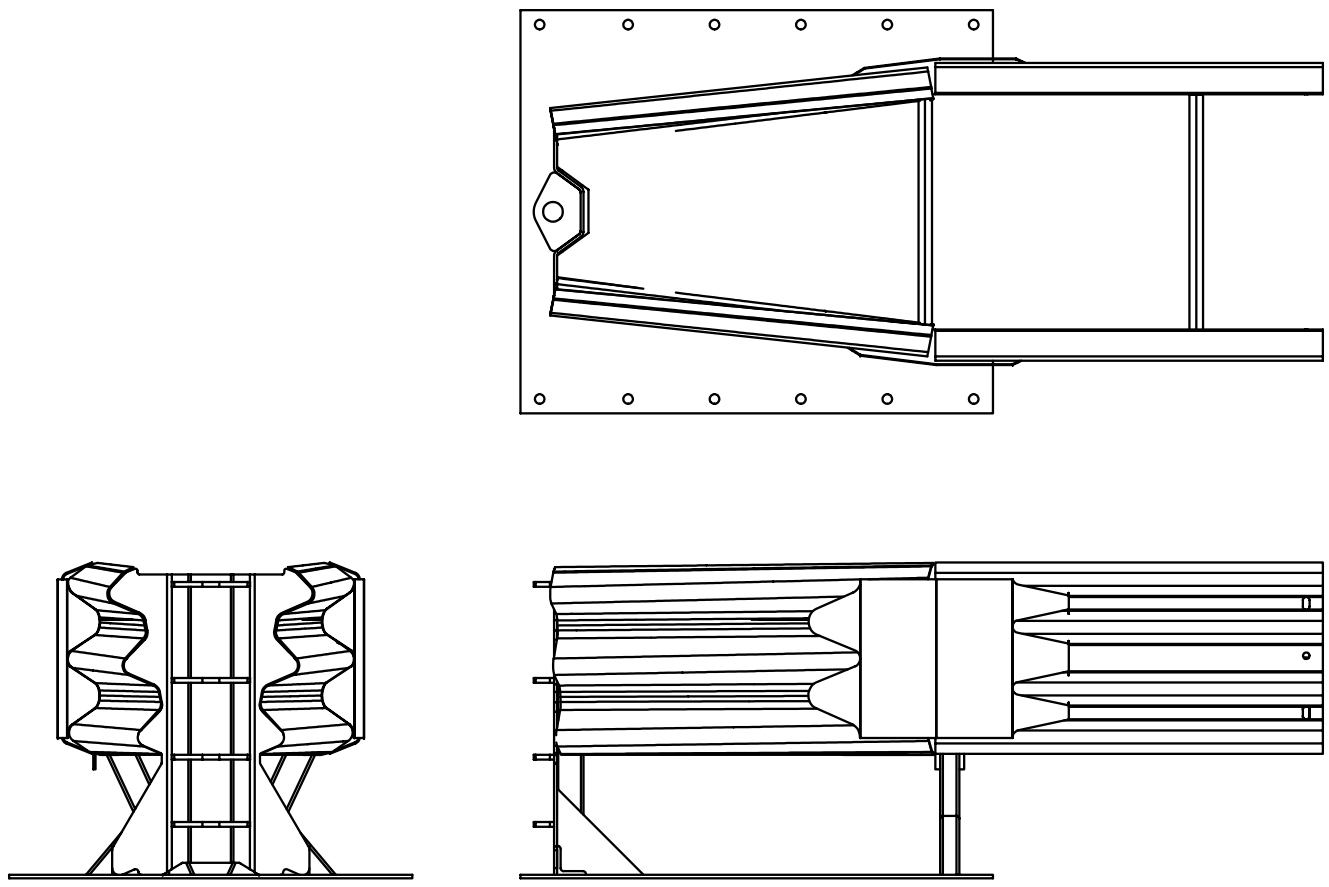
**Exit conditions**


Speed (km/h) .....	62
Angle (deg - veh. c.g.) .....	12
<b>Occupant Risk Values</b>	
Impact Velocity (m/s)	Primary / Backup*
x-direction .....	8.1 / 10.4
y-direction .....	7.5 / 5.4
Ridedown Acceleration (g's)	
x-direction .....	-23.5 / -13.7
y-direction .....	17.0 / 19.0
<b>European Committee for Normalization (CEN) Values</b>	
THIV (km/h) .....	38.4 / 42.1
PHD (g's) .....	25.1 / 19.8
ASI .....	1.9 / 1.4
<b>Test Article Deflections (m)</b>	
Dynamic .....	0.7
Permanent .....	0.4
<b>Vehicle Damage (Primary Impact)</b>	
Exterior	
VDS .....	LFQ-5
CDC .....	11FDEW4
Interior	
VCDI .....	LF0002000
Maximum Deformation (mm) .....	170
<b>Post-Impact Vehicular Behavior (deg - rate gyro)</b>	
Maximum Roll Angle .....	-25.4
Maximum Pitch Angle .....	-9.5
Maximum Yaw Angle .....	34.9

\* Primary accelerometers subjected to significant floorboard buckle.

**Summary of Results - Vulcan Barrier Transition to QuadGuard configuration tested.**

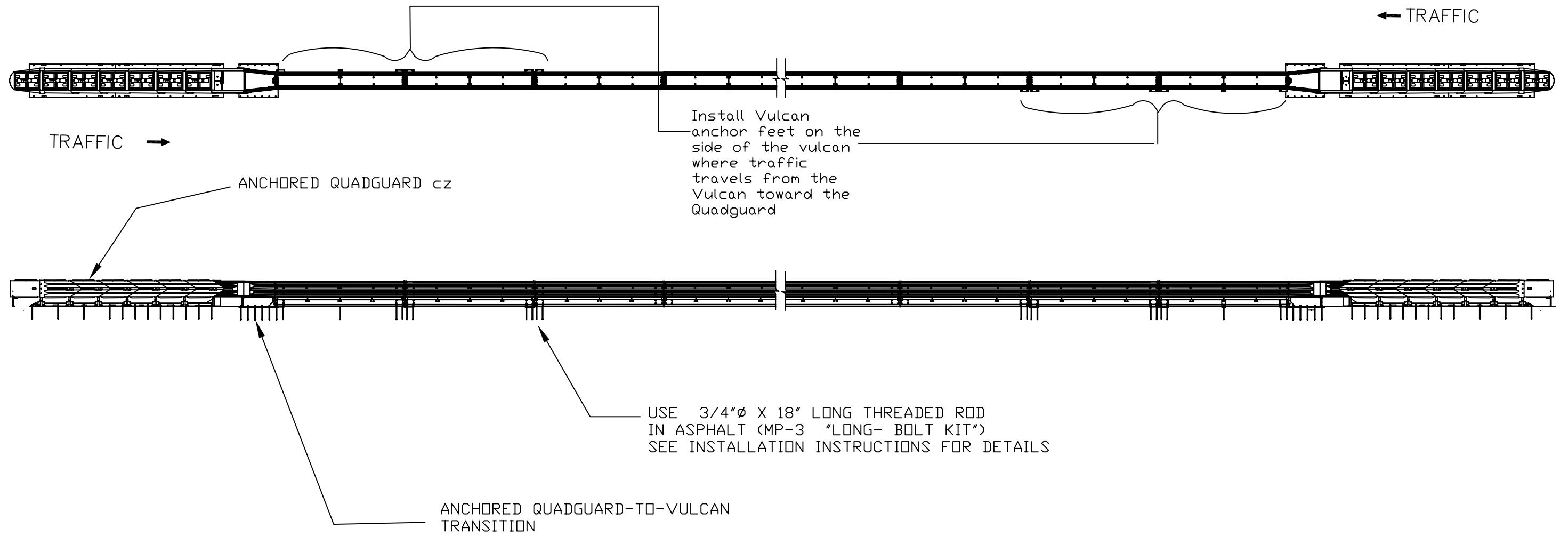
The results of this report relate only to the Vulcan Barrier Transition to QuadGuard configuration tested. This report may not be reproduced except in full, without the prior written approval of E-TECH Testing Services, Inc. Prepared by: John F. LaTurner, P.E. - Manager. Report 267 - Issued 8/31/05



DRAWN: klooney	DATE: 8/31/2005			
DESIGNED: klooney	DATE:			
CHECKED:	DATE:			
APPROVED:	DATE:			
Q.C.:	DATE:			
FILE: Quad to Vulcan Transition	SCALE:	DRAWING: Quad to Vulcan Transition	SHEET: 1 of 1	REV

Quad to Vulcan Transition

PARTS LIST			
ITEM	STOCK NO.	DESCRIPTION	REQ'D



REFERENCES

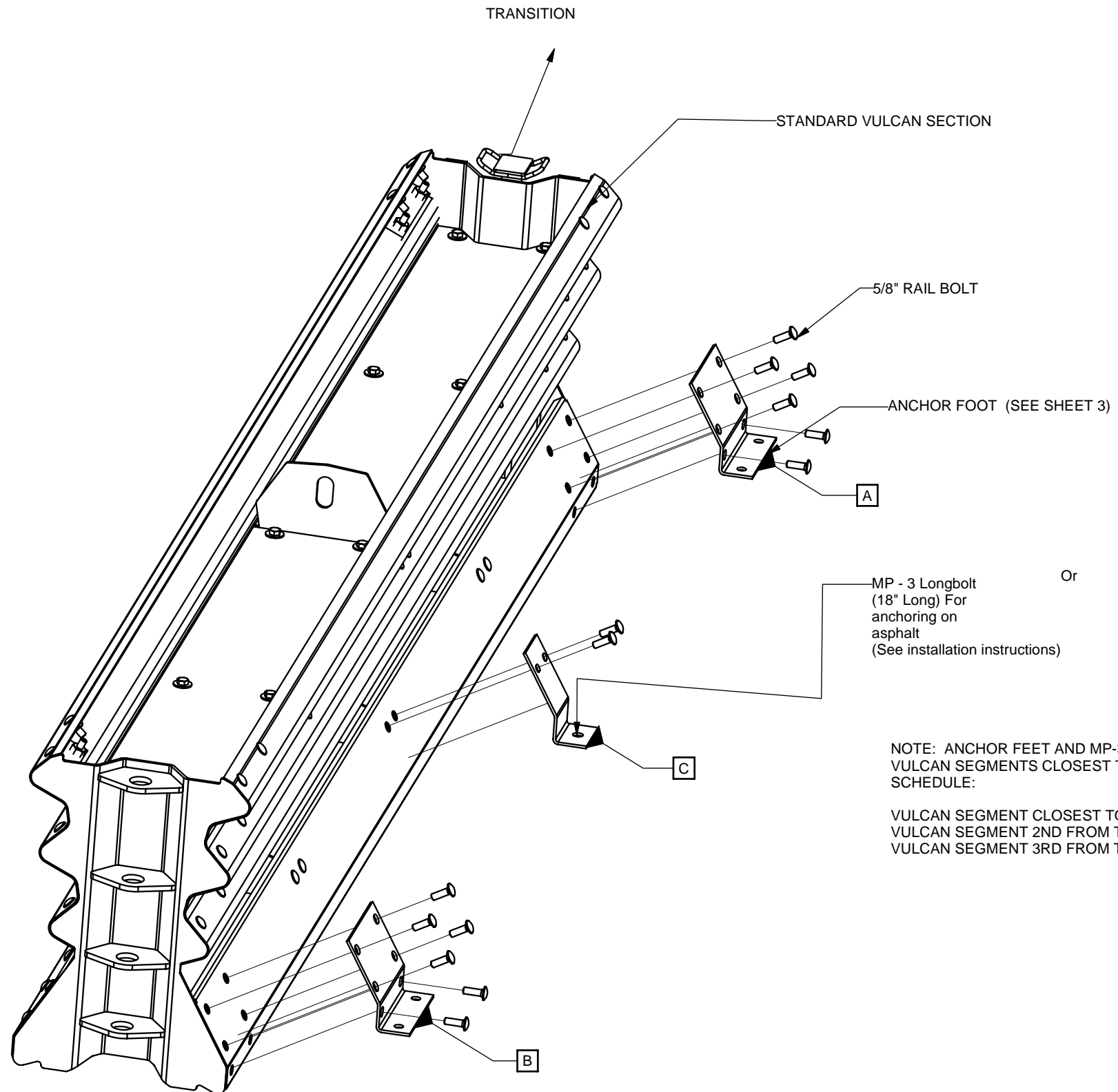
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DESIGNED:	DATE:
CHECKED:	DATE:
APPROVED:	DATE:
CAD FILE: Drawing.dwg.dwg	
NEXT ASSEMBLY:	



**ENERGY ABSORPTION SYSTEMS, INC.**  
ENGINEERING AND RESEARCH DEPARTMENT


VULCAN TO QUADGUARD  
TRANSITION

SCALE 1=1	DWG.	SHEET 1 of 3	REV
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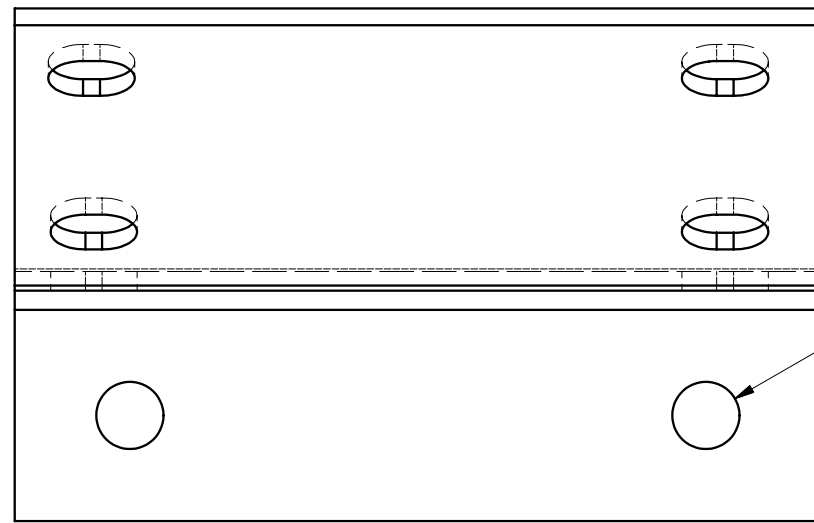


NOTE: ANCHOR FEET AND MP-3 ANCHORS TO BE USED ON THE THREE (3) VULCAN SEGMENTS CLOSEST TO THE TRANSITION PER THE FOLLOWING SCHEDULE:

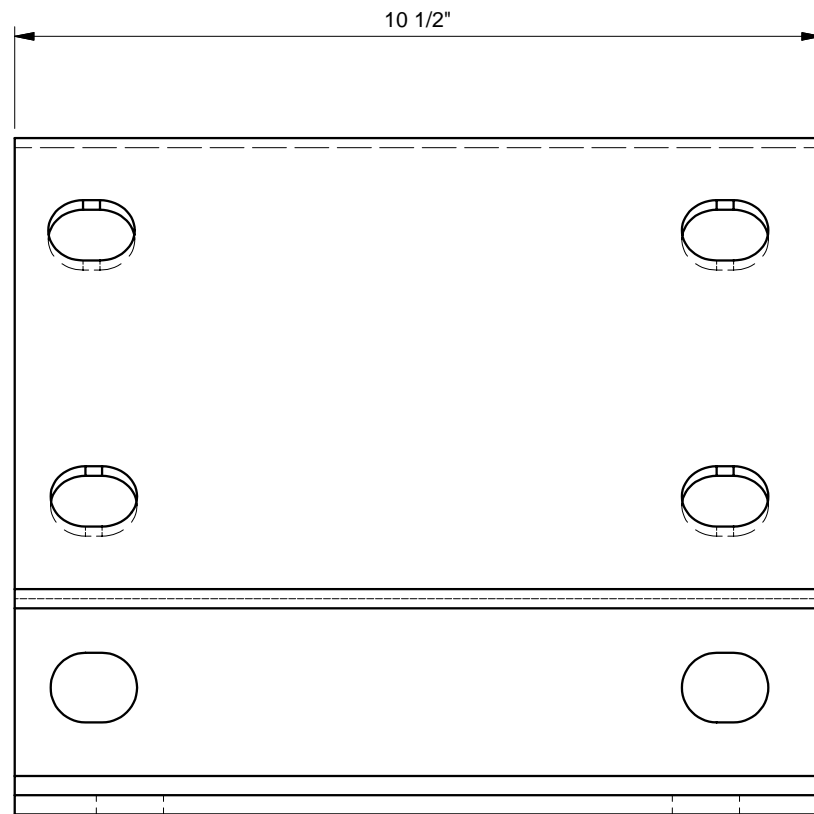
VULCAN SEGMENT CLOSEST TO THE TRANSITION = INSTALL ANCHORS A, B, & C  
 VULCAN SEGMENT 2ND FROM THE TRANSITION = INSTALL ANCHORS A & B  
 VULCAN SEGMENT 3RD FROM THE TRANSITION = INSTALL ANCHOR A

DRAWN: klooney	DATE: 11/1/2005			
DESIGNED: klooney	DATE:			
CHECKED:	DATE:			
APPROVED:	DATE:			
Q.C.:	DATE:			
FILE: anchor plate	SCALE:	DRAWING: anchor plate	SHEET: 2 of 3	REV

Vulcan anchor feet

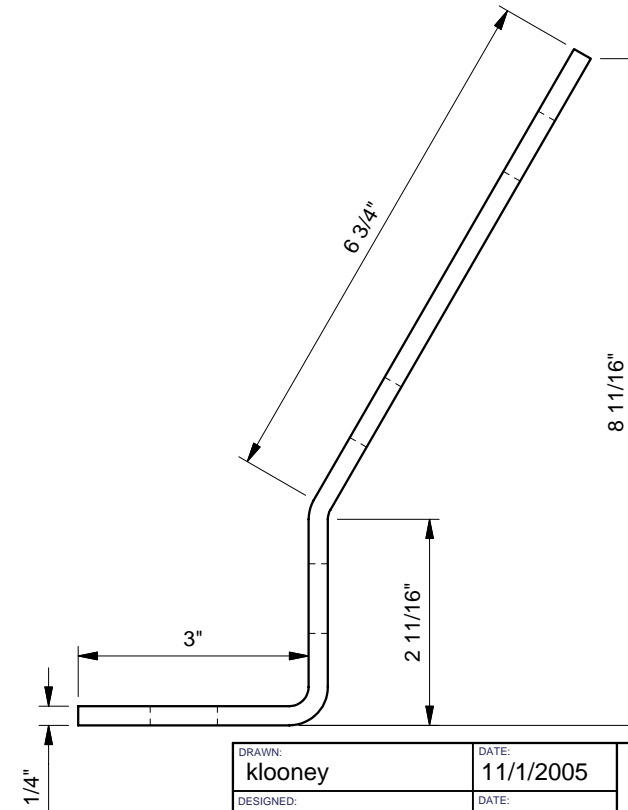
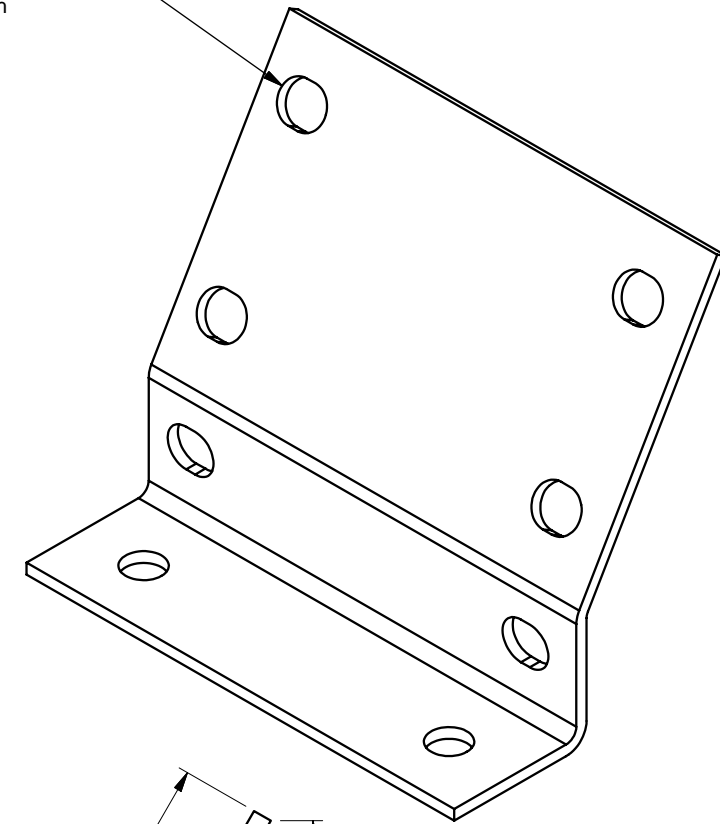


Ø7/8" Holes for anchor bolts



10 1/2"

Holes for 5/8" rail bolts to attach to Vulcan.

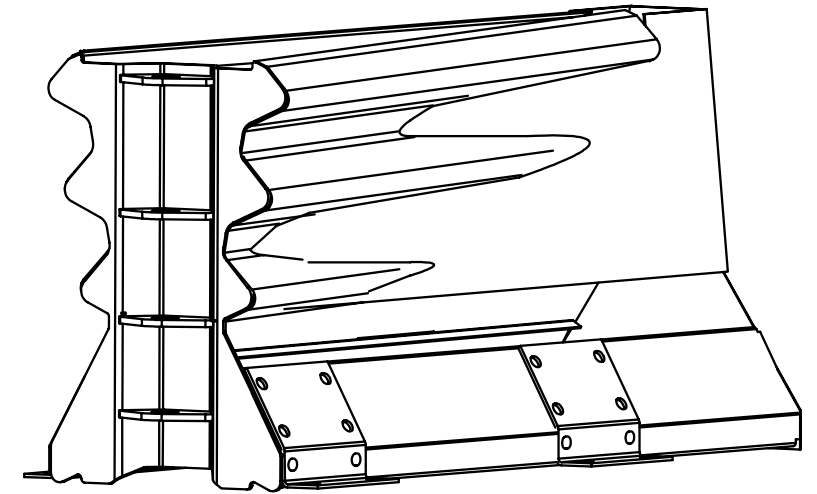
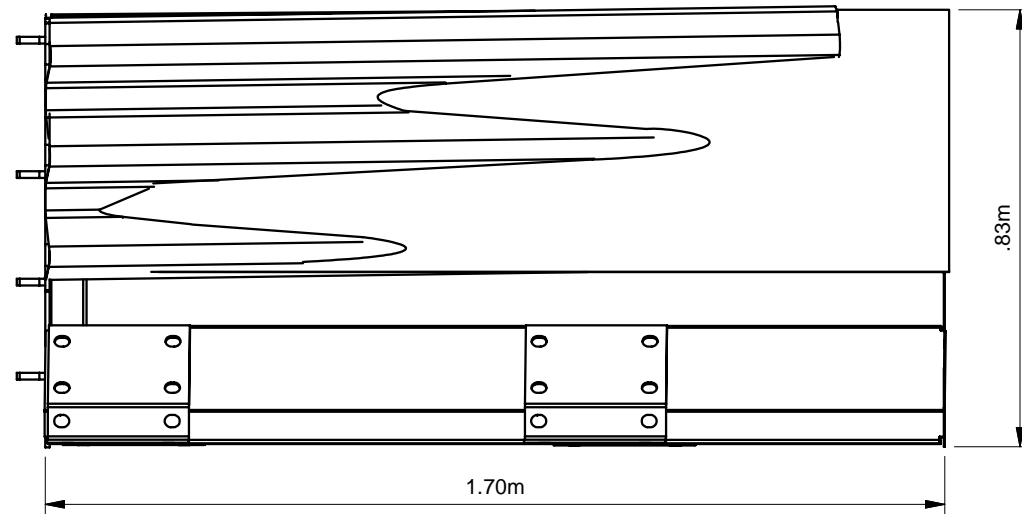
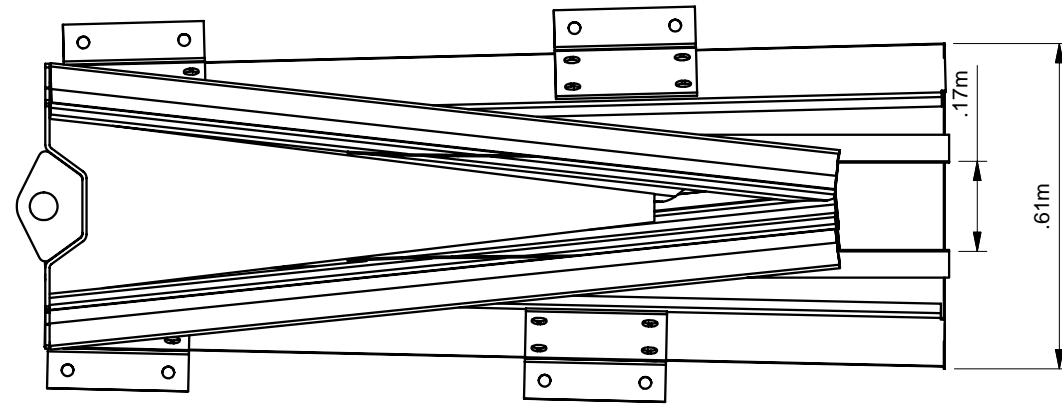
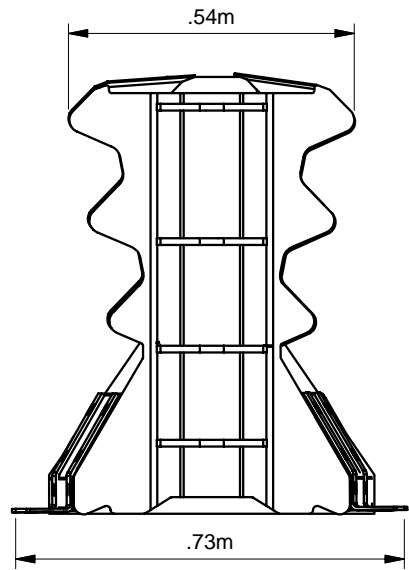



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DESIGNED: klooney	DATE:
CHECKED:	DATE:
APPROVED:	DATE:
Q.C.:	DATE:
FILE: anchor plate	

**ENERGY ABSORPTION SYSTEMS, INC.**  
ENGINEERING AND RESEARCH DEPARTMENT

Vulcan anchor feet

SCALE:	DRAWING: anchor plate	SHEET: 3 of 3	REV
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DRAWN: klooney	DATE: 11/10/2005			
DESIGNED: klooney	DATE:			
CHECKED:	DATE:			
APPROVED:	DATE:			
Q.C.:	DATE:			
FILE: CMB TRANS PSB	SCALE:	DRAWING: CMB TRANS PSB	SHEET: 1 of 1	REV

VULCAN-TO-CMB TRANSITION