June 19, 1997

Refer to: HNG-14

Mr. J. M. Essex, P.E.
Vice President, Sales
Energy Absorption Systems, Inc.
One East Wacker Drive
Chicago, Illinois 60601

Dear Mr. Essex:

Your March 26 letter to Mr. Gerald L. Eller requested the Federal Highway Administration (FHWA) to accept the Brakemaster System as a National Cooperative Highway Research Program (NCHRP) Report 350 test level 3 (TL-3) terminal. To support this request, you provided copies of your March 1997 report, "BRAKEMASTER System Qualification to NCHRP 350", which included information on three tests conducted in 1989 under NCHPR Report 230 guidelines and on five more recent tests by E-TECH Testing Services, Inc, conducted under NCHRP Report 350 guidelines. In addition to these test reports, drawings, photographs, and videotapes of the full-scale crash tests were also submitted. The results of the certification tests are summarized in Enclosure 1 for ready reference. In response to questions raised by my staff, you submitted supplemental information with your letters dated April 4, April 22, May 7, and June 9.

We note that the design for which you have requested FHWA acceptance (Enclosure 2) is identical to the NCHRP Report 230 Brakemaster terminal except for a new alternative end anchor detail. In addition to the original concrete footing anchor design, you have requested acceptance of an anchor assembly consisting of two 1981-mm long TS-203x152x4.8 steel tubes connected by a steel anchor (tension) strap 9.5-mm thick as detailed in drawing no. 9202024-0000 in Enclosure 2.

We agree that NCHRP Report 230 tests 44 and 45 correspond to NCHRP REPORT 350 tests 3-34 and 3-30, respectively, and that NCHRP Report 230 test S31 can be considered approximately equivalent to NCHRP Report 350 test 3-39 for the Brakemaster design features. We concur that all NCHRP Report 350 tests that were run (3-31, 3-32, 3-33, and 3-35) satisfactorily met appropriate evaluation criteria as noted in Enclosure 1. We have noted that test 3-35 was run twice, once with each of two different anchor designs, to show that, under maximum loading conditions, the recommended alternative anchor design, which has no soil bearing plates on the anchor tubes, performed as well as a developmental design, which incorporated shorter anchor tubes with soil bearing plates and a ground-level compression connecting strut and was used in three of the other NCHRP Report 350 certification tests (tests 3-31, 3-32 and 3-33).

Based on our review of the information presented, we have concluded that the Brakemaster design with either of the anchor assemblies shown in Enclosure 2 satisfies the NCHRP Report 350 evaluation criteria for a TL-3 terminal and that it may be used on the National Highway System (NHS) when selected by a highway agency. Since the Brakemaster is proprietary, all regulations regarding its use on Federal-aid projects (except non-NHS projects) remain applicable.

A copy of this letter and enclosures will be sent to the FHWA field offices for information.

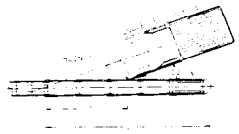
Sincerely yours,

(original signed by David A. Price)

for Dwight A. Horne, Chief
Federal-Aid and Design Division

2 Enclosures
Acceptance Letter CC-41

TABLE 1 -- SUMMARY OF TEST RESULTS SUBMITTED FOR CERTIFICATION OF THE BRAKEMASTER TO NCHRP 350 STANDARDS

NCHRP Evaluation Criteria	NCHRP 350 Equi-valent	Test ID.	Test Conditions	Impact Speed (km/hr)	Impact Angle (deg.)	Occupant Impact Velocity Long. (m/sec)	Occupant Impact Velocity Lateral (m/sec)	Ridedown Accelerations Long. (G)	Ridedown Accelerations Lateral (G)	Overall Assess-ment	Anchor and soil types used	Justification of NCHRP 230 test inclusion
NCHRP 230 Tests Included in Current Certification Program												
230-44	3-34	074-57	(See below.)									
230-45	3-30	074-56	(See below.)									
230-S31	3-39	074-46	(See below.)									
NCHRP 350 Certification Tests for TL3, Redirective, Gating End Terminal												
350-3-30	----	074-56		100.8	0	9.8	2.7	14.2	5.9	PASS[a]	Concrete pad	NCHRP 350 Test 3-30 is effectively equivalent to NCHRP 230 Test 45
350-3-31	----	01-7606-03		100.35	0	8.05	0.66	-14.13	-2.96	PASS[b]	5 ft foundation tube in weak soil (Appendix 2, Illustration D-3)	
350-3-32	----	01-7606-01		103.05	15	11.60	1.08	-16.57	6.21	PASS[b]	5 ft foundation tube in weak soil (Appendix 2, Illustration D-3)	
350-3-33	----	01-7606-02		93.34	14	7.46	0.49	-9.71	-3.40	PASS[b]	5 ft foundation tube in weak soil (Appendix 2, Illustration D-3)	
350-3-34	----	074-57		99.2	15	4.8	4.8	5.7	13.6	PASS[a]	Concrete pad	NCHRP 350 Test 3-34 is effectively equivalent to NCHRP 230 Test 44.
350-3-35		01-7606-04		99.37	21.0	6.73	1.27	-9.17	6.26	PASS[b]	Embedded (concrete) anchor in weak soil. (Appendix 2, Illustration D-6)	
350-3-35	----	01-7606-05		95.43[c]	20.5	3.06	3.09	-10.34	10.65	PASS[b,c]	6 1/2 ft foundation tube in standard soil. (Appendix 2, Illustration D-8)	
350-3-39	----	074-46		97.6	17[d]	5.8	4.5	13.5	11.7	PASS[a]	Concrete pad	NCHRP 350 Test 3-39 is effectively equivalent to NCHRP 230 Test S31.

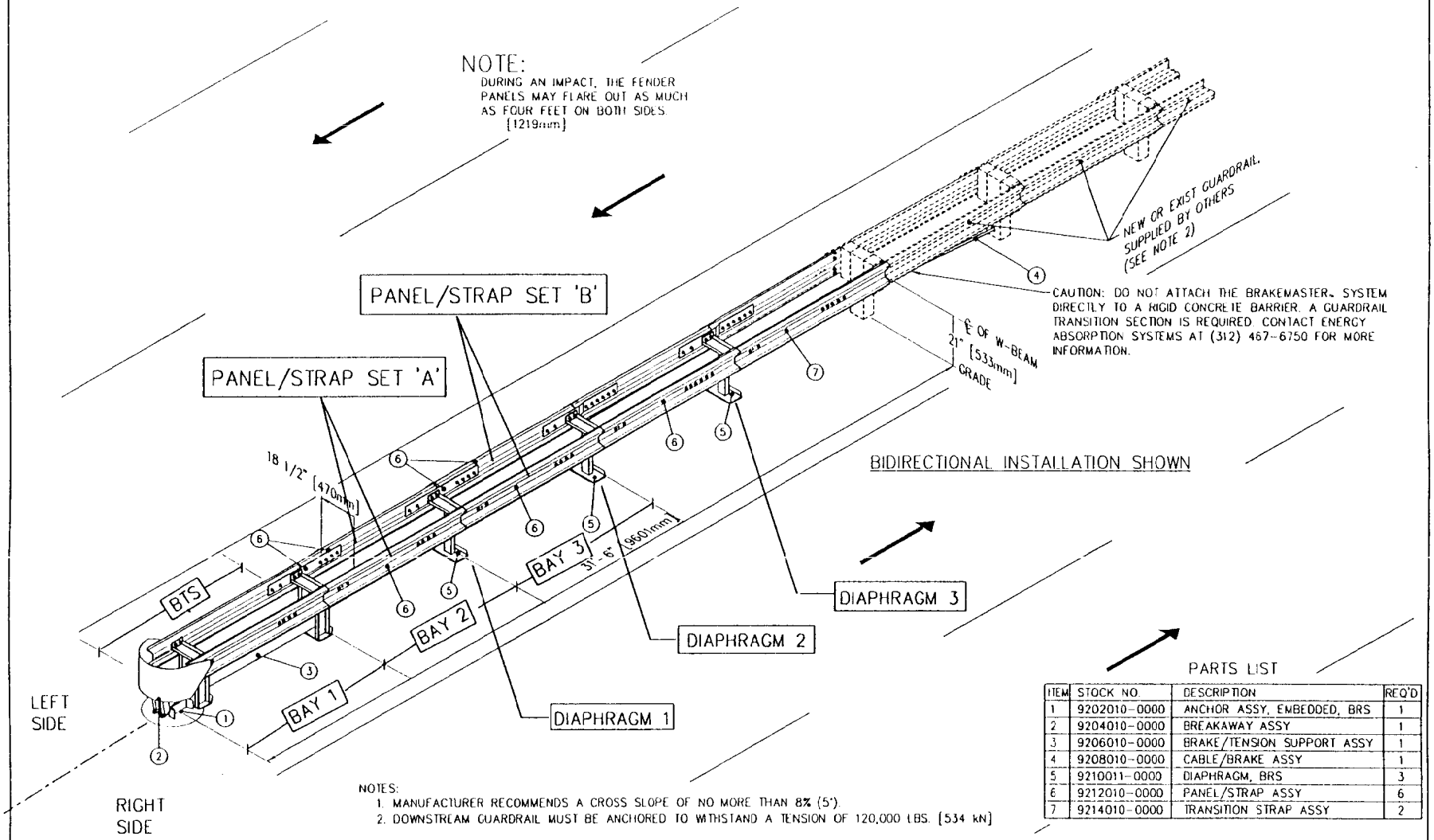
[a] See Appendix 1 for summary of NCHRP 230 test results from original BRAKEMASTER certification program, and evaluation of test in accordance with NCHRP 350 criteria.

[b] See E-Tech report (Appendix 2) for full test details.

[c] Impact speed is 0.57 kph below recommended range; however, impact severity is within recommended range. This was judged to be acceptable because: Test 01-7606-04 demonstrated that the structure is fully adequate so long as the nose anchorage is stable, and test 01-7606-05 demonstrated that the foundation tube anchor is sufficiently stable.

[d] The impact severity is less than recommended, because the impact angle is less than recommended. This was judged to be acceptable for two reasons. First, the BRS functions identically regardless of the direction of overlap of the fender panels. As a result, it is always installed so that the panels overlap away from traffic and there are never any snag points presented to traffic. Secondly, the front anchor capacity was verified in test 01-7606-05 (NCHRP 350-3-35).

BIDIRECTIONAL CONFIGURATION



NOTES:
1. MANUFACTURER RECOMMENDS A CROSS SLOPE OF NO MORE THAN 8% (5°).
2. DOWNSTREAM GUARDRAIL MUST BE ANCHORED TO WITHSTAND A TENSION OF 120,000 LBS. [534 kN]

PARTS LIST

ITEM	STOCK NO.	DESCRIPTION	REQ'D
1	9202010-0000	ANCHOR ASSY, EMBEDDED, BRS	1
2	9204010-0000	BREAKAWAY ASSY	1
3	9206010-0000	BRAKE/TENSION SUPPORT ASSY	1
4	9208010-0000	CABLE/BRAKE ASSY	1
5	9210011-0000	DIAPHRAGM, BRS	3
6	9212010-0000	PANEL/STRAP ASSY	6
7	9214010-0000	TRANSITION STRAP ASSY	2

MODEL NO. 106106BRS5

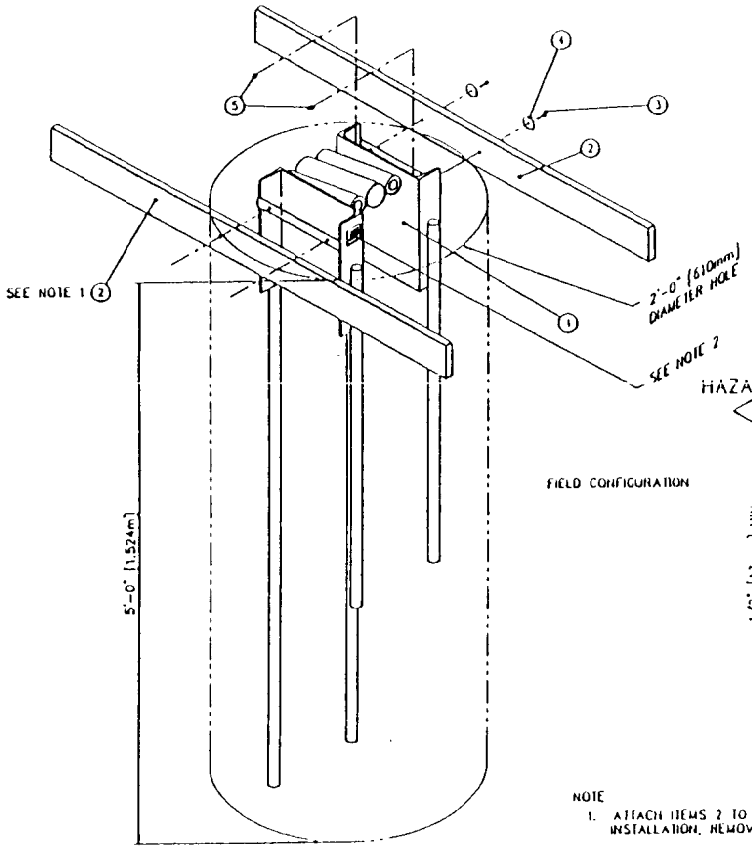
ENERGY ABSORPTION SYSTEMS, INC.
ENGINEERING AND RESEARCH DEPARTMENT

BRAKEMASTER SYSTEM (BRS)

GENERAL ASSEMBLY
(BIDIRECTIONAL SYSTEM)

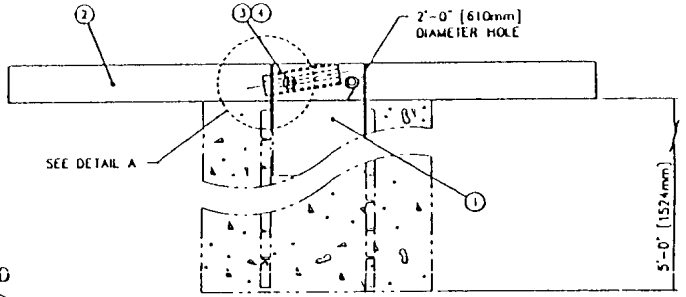
FIG 1

PARTS LIST			
ITEM	STOCK NO	DESCRIPTION	REQ'D
1	9202021-0000	ANCHOR, EMBEDDED, W/DECAL	1
2	9202031-0000	SUPPORT, WOOD, 1 x 4 x 48	2
3	2699141-0100	BOLT, HX, 1/4X1 3/4, G2, P	4
4	2708271-0000	WASHER, FLAT, 1/4 x 1 1/2, G	4
5	2704151-0100	NUT, HX, 1/4, P	4

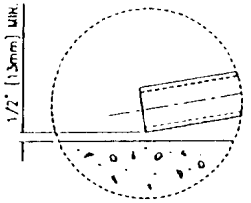


FIELD CONFIGURATION

HAZARD



SIDE VIEW



DETAIL A

CAUTION: Proper placement of this assembly is critical to the final assembly of the system. Read and follow the installation instructions.

NOTE

1. ATTACH ITEMS 2 TO ITEM 1 AS SHOWN PRIOR TO INSTALLATION. REMOVE AFTER CONCRETE HAS SET.
2. NOTE DIRECTION OF ANCHOR; SEE DECAL.

Revisions	Date	Rev	By	Chkd	Appd	Q.C
ITEM 3 WAS 2704433-0000 (1 3/4"LG)	5/21/90	A	OLS	DOS		
ADDED SIDE VIEW	5/21/90	A	OLS	DOS	DOS	
REMOVED ITEM 6, WAS 2733451-0000	8/13/90	B	BD	DOS	DOS	RLP
ADDED METRIC	5/28/91	C	OLS	BB	SPT	
ITEMS 3&5 WERE SCREW & NUT WASHER	5/28/92	D	TB	BB	SPT	DLJ
ITEM 3 WAS 2701411-0100 IN ERROR	8/6/92	E	TB	BB	SPT	

		Date
Designed		
Drawn	MECOL B	7/27/89
Checked	B B L	11/13/89
Approved	W b Kuyp	11/13/89
Q.C.	R L Parkinson	11/13/89

Tolerances:
a. Angular ±
b. Linear ±
(Unless Otherwise Noted)

Material:
SEE DETAIL DRAWINGS

REFERENCES

NEXT ASSEMBLY 92-00-03

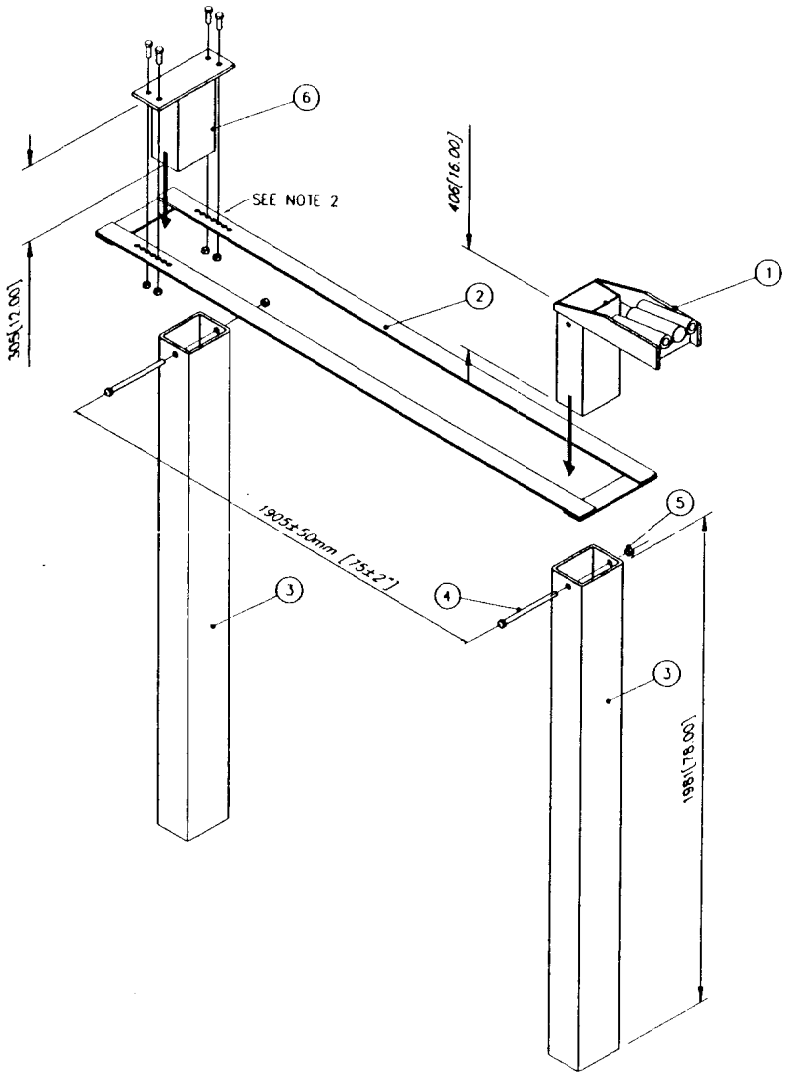
ASSEMBLY NO. 9202010-0000

ENERGY ABSORPTION SYSTEMS, INC.
ENGINEERING AND RESEARCH DEPARTMENT

BRAKEMASTER

ANCHOR ASSY, EMBEDDED, BRS

SCALE (1:8)	SIZE	DWG NUMBER	SHEET	REV
1/8" = 1'	C	92-02-01		E



PARTS LIST			
ITEM	STOCK NO	DESCRIPTION	REQ'D
1	9202025-0000	ANCHOR ADAPTER,BTS TO FOUND. TUBE	1.0(
2	9202026-0000	ANCHOR STRAP,BRS	1.0(
3	9202028-0000	FOUNDATION TUBE,78,BRS	2.0(
4	2701992-0000	BOLT,HX,5/8X1G,G5,G	2.0(
5	2704191-0000	NUT,HX,5/8,G,RAIL	2.0(
6	9202033-0000	ANCHOR PLUG, FOUNDATION TUBE	1.0(

NOTES:
1. TIGHTEN NUTS 1/2 TURN BEYOND SNUG
2. EXTRA HOLES IN ITEM 2 ARE FOR ±50mm[2"] TOLERANCE.
3. DIMENSIONS ARE IN mm [inches]

Revisions	Date	Rev	By	Ckd	App
WAS A SIZE BORDER	2/14/97	A	STI	KM	WGK
ADDED ITEM 6, REV'D ITEM 2	3/5/97	B	STI	KM	WGK
ADDED DIMENSIONS	3/24/97	C	JE	KM	

REFERENCES

DRAWN STRAGESER	DATE 12/17/96
DESIGNED B. Krage	DATE 12/13/96
CHECKED KRM	DATE 12/26/96
APPROVED WGK	DATE 12/23\96
CAD FILE 9202024-0000 dwg	
NEXT ASSEMBLY 92-00-02	
	92-00-01

ASSEMBLY NO 9202024-0000

ENERGY ABSORPTION SYSTEMS, INC.
ENGINEERING AND RESEARCH DEPARTMENT

ANCHOR ASSY,FOUNDATION TUBE, 6 1/2 FT.,BRS

SCALE	DWG	SHEET	REV
1:18	9202024-0000	1 of 1	C

Page 1 of 1