



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

June 28, 1995

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

Refer to: HNG-14

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

Dear Mr. Essex:

Your March 1 letter to Mr. William A. Weseman referenced an earlier meeting you had with members of my staff, during which you provided videotapes and a written report documenting the National Cooperative Highway Research Program (NCHRP) Report 350 test level 3 (TL-3) performance of your Energite III (Sand Barrel) crash cushion. At that meeting, you requested that this office delay formal action on your request pending implementation of changes reflecting the metrication transition and of an educational campaign designed for the end-user of your product.

On May 30 you wrote to Mr. Weseman requesting the Federal Highway Administration (FHWA) to proceed with our review process and to respond to some specific issues addressed in that second letter.

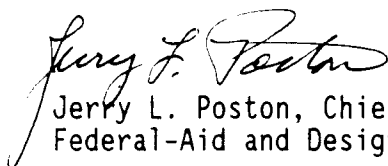
Each module in the Energite III array consists of a solid plastic barrel with a lid. The amount of sand placed in each barrel and its center of gravity are controlled by an inner cone that rests inside each of the three lightest weight modules. Based on some preliminary crash tests to evaluate the performance of an Energite III array per the NCHRP Report 350 matrix for a TL-3, non-redirective crash cushion, a 12-barrel standard array was selected for compliance testing. From front to back, the tested array consisted of one single 90-kg (200-pound) module, two rows of single 180-kg (400-pound) modules, one single 320-kg (700-pound) module, two rows of two 320-kg (700-pound) units, one row of two 640-kg (1400-pound) units, and finally, one row of two 960-kg (2100-pound) units. Each module was spaced approximately 150 mm to 200 mm apart, with the rear-most barrels at least 300 mm from the shielded object with a minimum 760-mm lateral offset from the corner of the hazard.

The NCHRP Report 350 tests 3-40 through 3-44 were conducted on the array described above. Test results are shown on the enclosed excerpts from the Energite III crash test report dated May 1994. The occupant risk measurements are summarized on Table C-1 from the report, which is also enclosed.

Based on the above noted test results, we concur with your finding that the Energite III array, as tested, fully meets the NCHRP Report 350 requirements for a TL-3 non-redirective crash cushion and it may continue to be used on the National Highway System (NHS) when selected by a highway agency. All requirements pertaining to the use of a proprietary product on federally-funded projects (except exempt non-NHS projects) remain in effect. By a copy of this letter, we will inform our field offices of this determination.

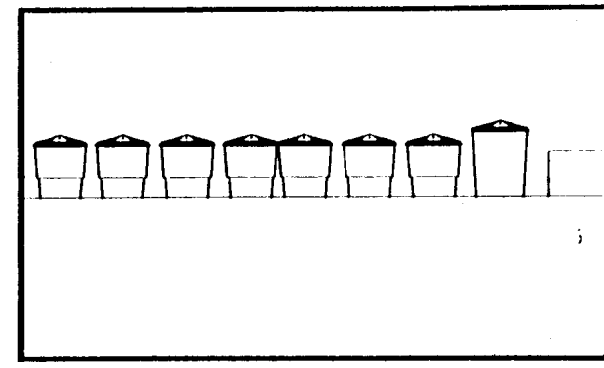
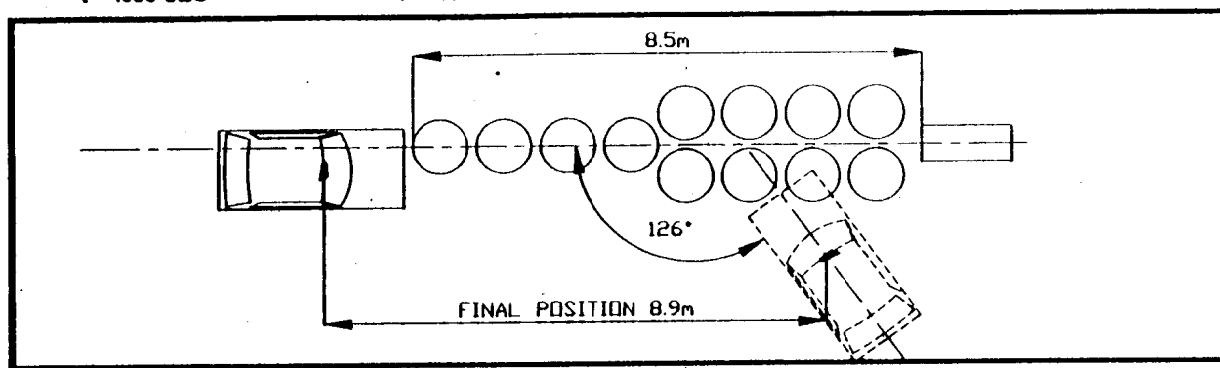
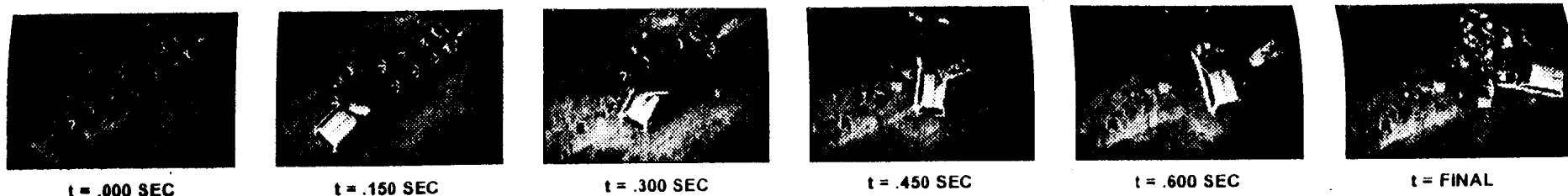
Two other items addressed in your May 30 letter concerned the selection of a design procedure that will address the multiple test level designations contained in the NCHRP Report 350 and FHWA's current position on the use of single-row sand barrels in work zones. We believe it appropriate to address both of these concerns in a separate letter and we will do so in the near future.

Sincerely yours,


Jerry L. Poston, Chief
Federal-Aid and Design Division

2 Enclosures

Geometric and Roadside Design Acceptance Letter CC-29



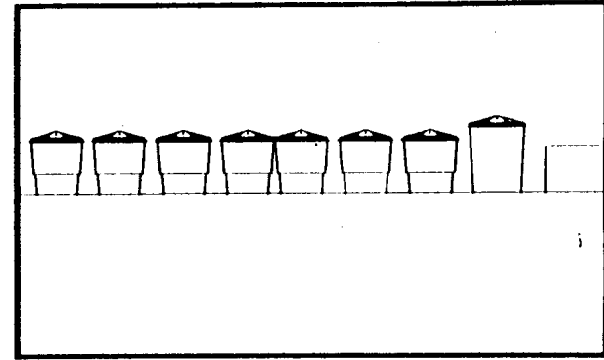
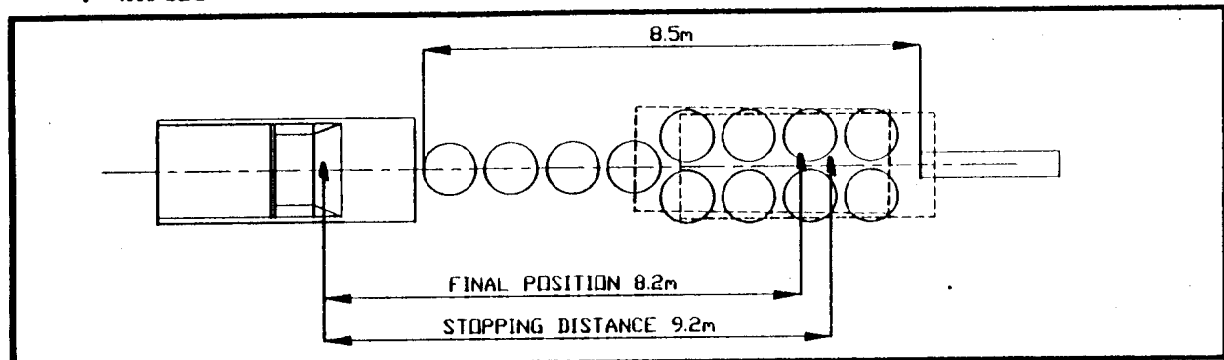
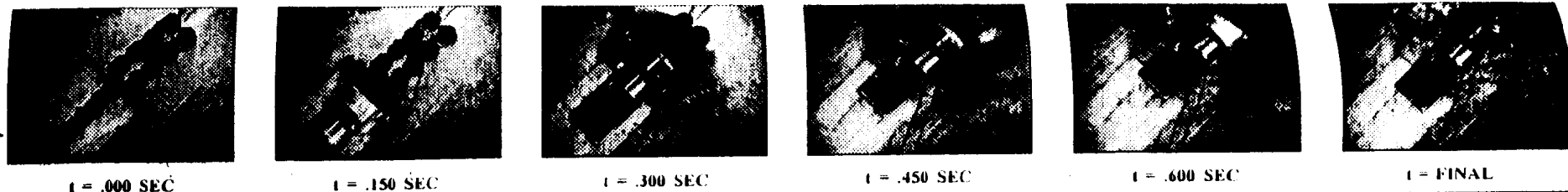
General Information

Test No. 177-011
 Date Jan 10, 1994
Test Article
 Type Energite III
 Installation Length (m) 8.5
 Size and/or dimension and material
 of key elements N/A
 Soil Type and Condition Clean Dry PCC
Test Vehicle
 Type Production Model
 Designation 820C
 Model 1988 Ford
 Festiva
 Mass (kg)
 Curb 762
 Test inertial 818
 Dummy(s) 75
 Gross Static 893
Impact conditions
 Speed (km/h) 100.5
 Angle (deg) 0
 Impact Severity (kJ) 319.1

Exit conditions

Speed (km/h) N/A
 Angle (deg) N/A
Occupant Risk Values
 Impact Velocity (m/s)
 x-direction 7.99
 y-direction 0.06
 Ridedown Acceleration (g's)
 x-direction -12.46
 y-direction -6.30
 Acceleration Severity Index 0.77
Test Article Deflection (m)
 Dynamic N/A
 Permanent N/A
Vehicle Damage
Exterior
 VDS FD-5
 CDC 12FDEW5
Interior
 OCDI AS0000000
Post-Impact Vehicular Behavior
 Maximum Roll Angle (deg) -12.5
 Maximum Pitch Angle (deg) -5.3
 Maximum Yaw Angle (deg) -126.3

Figure 1. Summary of Results - Energite III Test 177-011 (NCHRP 350 Test 3-40)



General Information

Test No. 177-015
 Date April 22, 1994

Test Article

Type Energite III
 Installation Length (m) 8.5
 Size and/or dimension and material
 of key elements N/A

Soil Type and Condition Clean Dry PCC

Test Vehicle

Type Production Model
 Designation 2000P
 Model 1988 GMC
 Sierra 2500

Mass (kg)

Curb 1923
 Test inertial 2005
 Dummy(s) N/A
 Gross Static 2005

Impact conditions

Speed (km/h) 102.8
 Angle (deg) 0
 Impact Severity (kJ) 817.1

Exit conditions

Speed (km/h) N/A
 Angle (deg) N/A

Occupant Risk Values

Impact Velocity (m/s)
 x-direction 7.96
 y-direction 0.01
 Ridedown Acceleration (g's)
 x-direction -14.22
 y-direction 3.06

Acceleration Severity Index 0.69

Test Article Deflection (m)

Dynamic N/A
 Permanent N/A

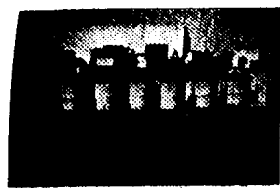
Vehicle Damage

Exterior
 VDS FD-4
 CDC 12FDEW4
 Interior
 OCDI AS0000000

Post-Impact Vehicular Behavior

Maximum Roll Angle (deg) -2.4
 Maximum Pitch Angle (deg) -5.2
 Maximum Yaw Angle (deg) 3.5

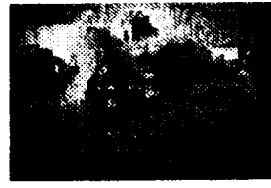
Figure 6. Summary of Results - Energite III Test 177-015
 (NCHRP 350 Test 3-41)



t = .000 SEC



t = .150 SEC



t = .300 SEC



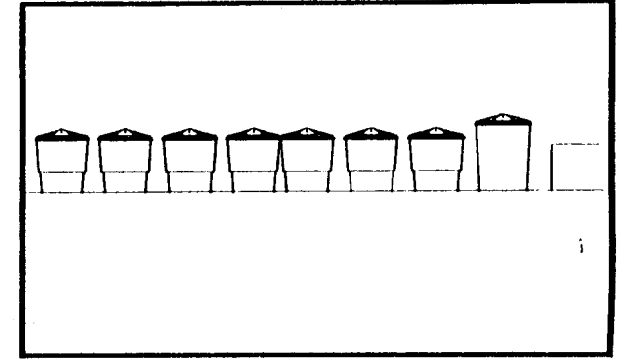
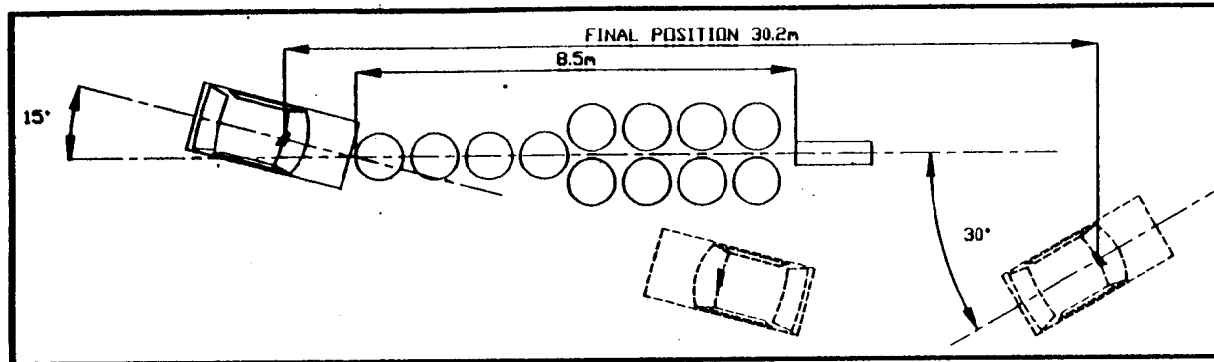
t = .450 SEC



t = .600 SEC



t = FINAL



General Information

Test No. 177-006
 Date Sept. 22, 1993

Test Article

Type Energite III
 Installation Length (m) 8.5
 Size and/or dimension and material
 of key elements N.A.

Soil Type and Condition Clean Dry PCC

Test Vehicle

Type Production Model
 Designation 820C
 Model 1987 Honda
 Civic
 Mass (kg)
 Curb 853
 Test Inertial 843
 Dummy(s) 75
 Gross Static 918

Impact Conditions

Speed (km/h) 103.0
 Angle (deg) 15
 Impact Severity (kJ) 345.1

Exit conditions

Speed (km/h) 42.8
 Angle (deg) 30

Occupant Risk Values

Impact Velocity (m/s)
 x-direction 7.00
 y-direction 0.24
 Ridedown Acceleration (g's)
 x-direction -12.98
 y-direction -8.15

Acceleration Severity Index 0.71

Test Article Deflection (m)

Dynamic N.A.
 Permanent N.A.

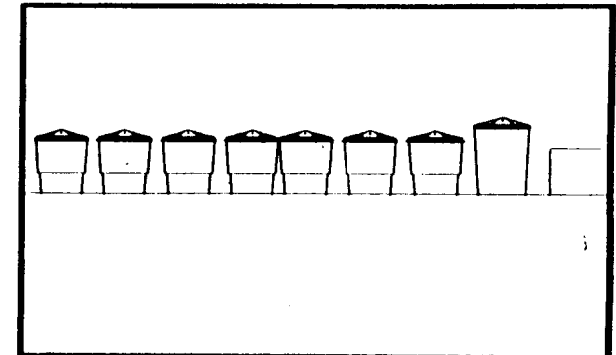
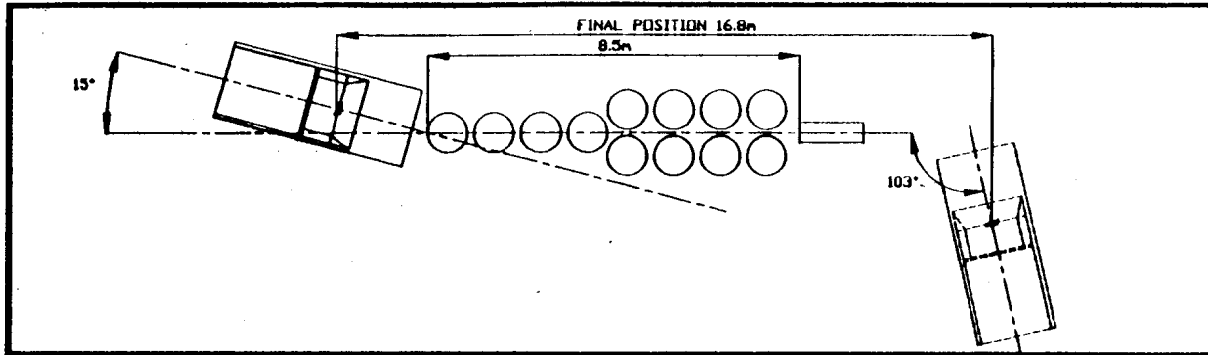
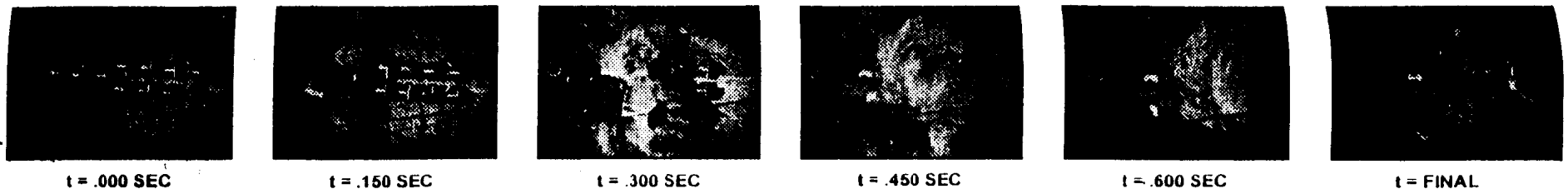
Vehicle Damage

Exterior
 VDS FL-4
 CDC 11FYAW6
 Interior
 OCDI AS0000000

Post-Impact Vehicular Behavior

Maximum Roll Angle (deg) 7.0
 Maximum Pitch Angle (deg) -7.4
 Maximum Yaw Angle (deg) -180.3

Figure 11. Summary of Results - Energite III Test 177-006
 (NCHRP 350 Test 3-42)



General Information

Test No. 177-005
 Date Sept. 15, 1993

Test Article

Type Energite III
 Installation Length (m) 8.5
 Size and/or dimension and material
 of key elements N.A.

Soil Type and Condition Clean Dry PCC

Test Vehicle

Type Production Model
 Designation 2000P
 Model 1988 Chevrolet
 Cheyenne

Mass (kg)

Curb 1855
 Test Inertial 2016
 Dummy(s) N.A.
 Gross Static 2016

Impact Conditions

Speed (km/h) 101.9
 Angle (deg) 15
 Impact Severity (kJ) 807.9

Exit conditions

Speed (km/h) 53.5
 Angle (deg) 6

Occupant Risk Values

Impact Velocity (m/s)
 x-direction 6.51
 y-direction 0.47
 Ridedown Acceleration (g's)
 x-direction -9.02
 y-direction 6.45

Acceleration Severity Index 0.52

Test Article Deflection (m)

Dynamic N.A.
 Permanent N.A.

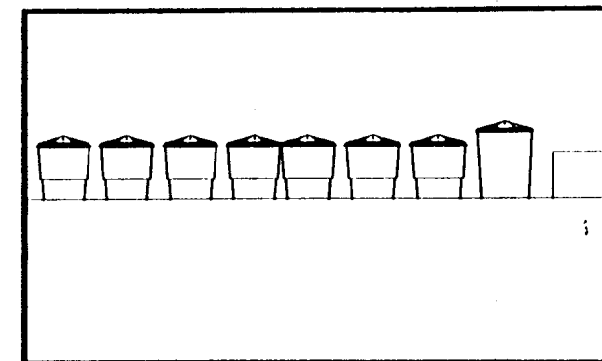
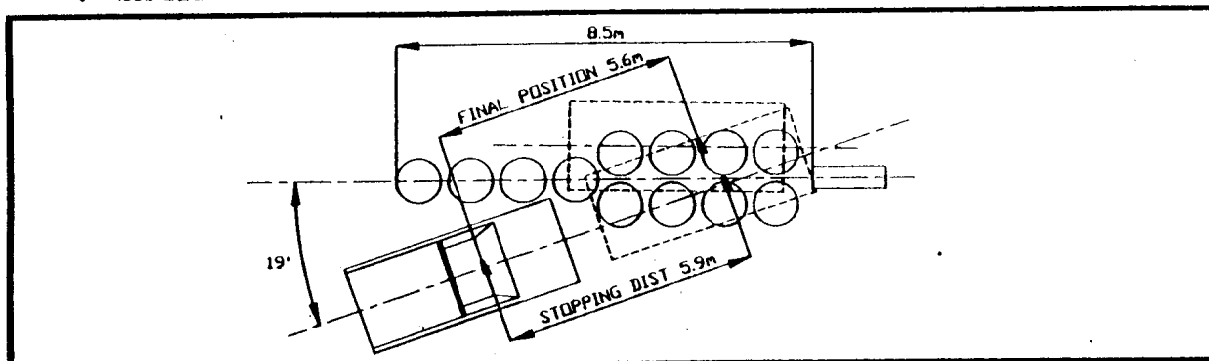
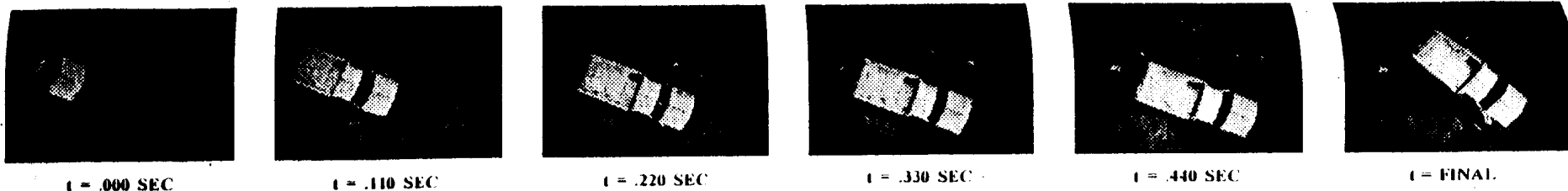
Vehicle Damage

Exterior
 VDS (primary / secondary) FL-5 / RFQ-6
 CDC (primary / secondary) 11FYAW5 / 01FZAW6
 Interior
 OCDI (primary / secondary) AS0000000 / RF0012000

Post-Impact Vehicular Behavior

Maximum Roll Angle (deg) -3.4
 Maximum Pitch Angle (deg) -8.1
 Maximum Yaw Angle (deg) -118.3

Figure 16. Summary of Results - Energite III Test 177-005
 (NCHRP 350 Test 3-43)



General Information

Test No. 177-016
 Date May 4, 1994
Test Article
 Type Energite III
 Installation Length (m) 8.5
 Size and/or dimension and material
 of key elements N/A
 Soil Type and Condition Clean Dry PCC
Test Vehicle
 Type Production Model
 Designation 2000P
 Model 1990 GMC
 3/4 ton P/U
 Mass (kg)
 Curb 1950
 Test inertial 1964
 Dummy(s) N/A
 Gross Static 1964
Impact conditions
 Speed (km/h) 96.5
 Angle (deg) 19
 Impact Severity (kJ) 705.3

Exit conditions

Speed (km/h) N/A
 Angle (deg) N/A
Occupant Risk Values
 Impact Velocity (m/s)
 x-direction 9.71
 y-direction 0.54
 Ridedown Acceleration (g's)
 x-direction -14.13
 y-direction -9.75
 Acceleration Severity Index 0.86
Test Article Deflection (m)
 Dynamic N/A
 Permanent N/A
Vehicle Damage
 Exterior
 VDS FD-5
 CDC 12FDEW-4
 Interior
 OCBI AS0000000
Post-Impact Vehicular Behavior
 Maximum Roll Angle (deg) -12.4
 Maximum Pitch Angle (deg) -4.4
 Maximum Yaw Angle (deg) 17.2

Figure 21. Summary of Results - Energite III Test 177-016
 (NCHRP 350 Test 3-44)

eled either 0.6 m forward or 0.3 m lateral, whichever is smaller. The flail space time was determined by incremental integration of the vehicular acceleration. The acceleration in the x direction was integrated twice with respect to time to find the flail space time at which the double integration equals 0.6 m. Acceleration in the y direction was integrated twice with respect to time to find the flail space time at which the double integration equals 0.3 m. Finally, a 10 ms moving average of the x and y vehicular accelerations were taken, and the ridedown accelerations were reported as the highest 10 ms average vehicular accelerations in the x and y directions subsequent to the flail space time.

The Acceleration Severity Index (ASI) was calculated according to the procedures contained in

NCHRP 350 Section F3.1. A 50 ms moving average of the x, y, and z vehicular accelerations are taken and then normalized by dividing by their respective limit accelerations (12, 9, and 10 g's, respectively). These values were then squared and summed, and the ASI was computed as a function of time as the square root of this sum. Occupant risk is assumed to be proportional to the maximum value of the ASI.

Table C-1 contains a summary of the occupant impact velocity, ridedown accelerations, and acceleration severity index for Energite III Tests 177-011, 177-015, 177-006, 177-005, and 177-016. The vehicle angular displacements, longitudinal, lateral, and vertical g-trace and occupant kinematics, 10ms average vehicle accelerations, and ASI plots for these tests are shown in Figure C-3 through C-32.

Table C-1. Summary of Energite III Occupant Risk Measurements

NCHRP 350 Test Number	EASI Test Number	Flail Space Velocity		Ridedown Acceleration		Acceleration Severity Index
		Longitudinal	Lateral	Longitudinal	Lateral	
3-40	177-011	7.99 m/s @ 0.145 s	0.06 m/s @ 0.145 s	-12.46 g's @ 0.174 s	-6.30 g's @ 0.312 s	0.77 @ 0.214 s
3-41	177-015	7.97 m/s @ 0.164 s	0.02 m/s @ 0.164 s	-14.26 g's @ 0.347 s	3.06 g's @ 0.230 s	0.69 @ 0.219 s
3-42	177-006	7.00 m/s @ 0.151 s	0.24 m/s @ 0.151 s	-12.98 g's @ 0.286 s	-8.15 g's @ 0.224 s	0.71 @ 0.298 s
3-43	177-005	6.51 m/s @ 0.179 s	0.47 m/s @ 0.179 s	-9.02 g's @ 0.264 s	6.45 g's @ 0.252 s	0.52 @ 0.271 s
3-44	177-016	9.71 m/s @ 0.138 s	0.54 m/s @ 0.138 s	-14.13 g's @ 0.205 s	-9.75 g's @ 0.414 s	0.86 @ 0.245 s