

March 26, 1999

Refer to: HMHS-

CC58

Keith R. Lane, P.E.
Director of Research and Materials
Connecticut Department of Transportation
280 West Street
Rocky Hill, CT 06067-3502

Dear Mr. Lane:

In your February 22 letter to the Director of the Federal Highway Administration's Office of Engineering, you requested acceptance of the Narrow Connecticut Impact Attenuation System (NCIAS) as an NCHRP Report 350 test level 3 (TL-3) crash cushion for use on the National Highway System (NHS). To support your request, you also sent us two copies each of crash test reports prepared by the Texas Transportation Institute on Report 350 tests 3-32, 3-33, 3-37, 3-38, and 3-39. These were the tests recommended by Mr. Dwight A. Horne in his April 18, 1997 response to Dr. Charles E. Dougan.

The NCIAS consists of eight steel cylinders in a single row with two anchored wire ropes along each side. All cylinders are 900 mm in diameter and 1200 mm tall. Wall thicknesses vary from 3.2 mm to 9.5 mm. Enclosure 1 shows the general configuration and details of the first two cylinders.

We have reviewed the information you submitted and concur that the appropriate Report 350 evaluation criteria were met for tests 3-32, 3-33, and 3-37. We noted that test 3-38 was repeated after an initial failure (excessive passenger compartment deformation) and that the additional stiffening of cylinder No. 8 produced satisfactory results. We noted also that the reverse-direction hit (test 3-39) resulted in vehicle snagging and unacceptable passenger compartment intrusion. In lieu of additional design changes and further testing, you opted to prohibit the use of the NCIAS in locations where wrong-way hits are likely. Enclosure 2 consists of summary sheets of the tests run under Report 350.

Based on our review, we consider the NCIAS to meet the evaluation criteria for an NCHRP Report 350 crash cushion at TL-3 and it may be used on the NHS (at locations where reverse-direction impacts are unlikely) when selected by a transportation agency. Although the NCIAS is patented, we understand that the rights to manufacture and use the system are non-proprietary and that plans and specifications may be obtained through your office.

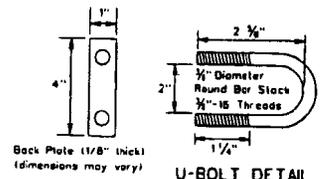
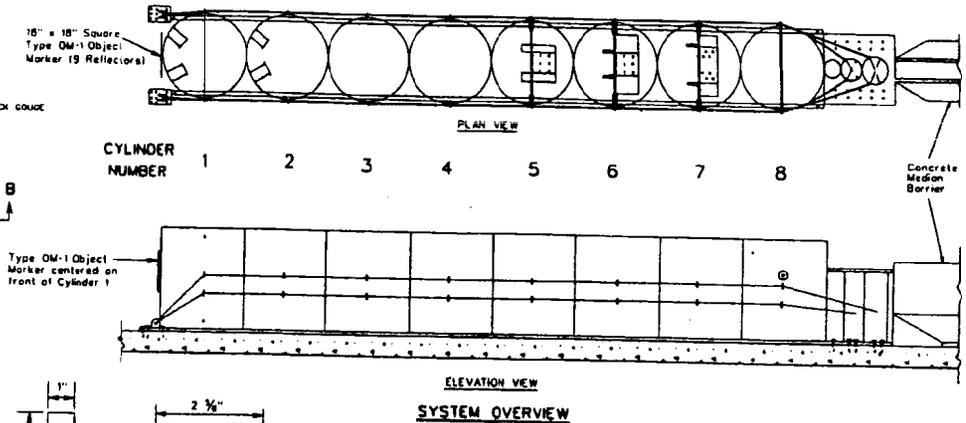
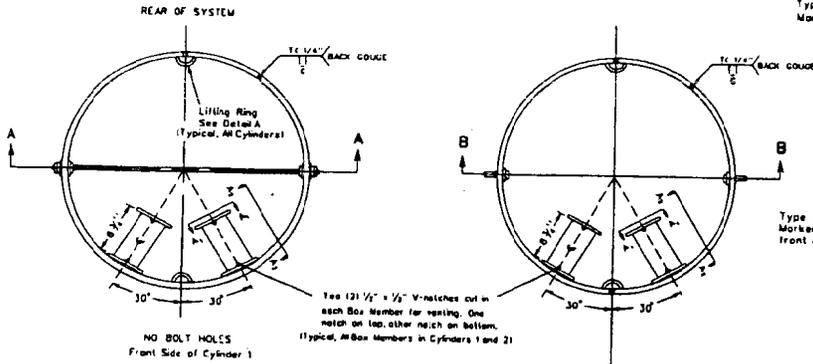
Sincerely yours,

(original signed by Dwight A. Horne)

Dwight A. Horne
Director, Office of Highway Safety Infrastructure

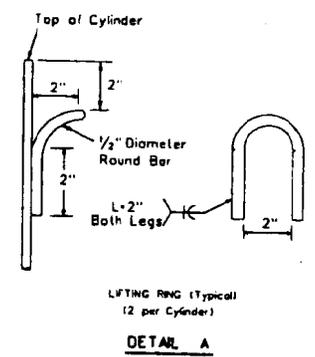
2 Enclosures

NOTE: Cylinder 1 has Eye Bolts
Cylinders 2 Thru 8 have U-Bolts

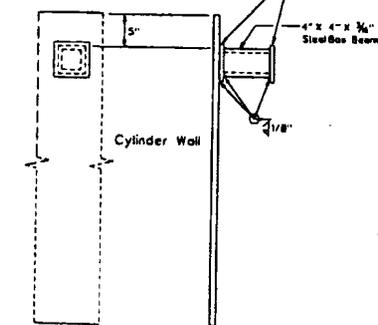
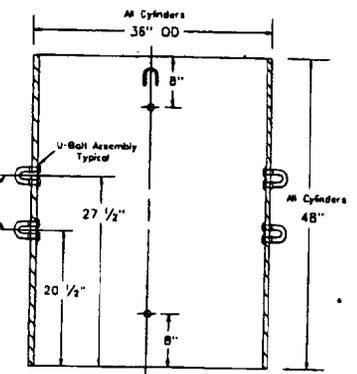
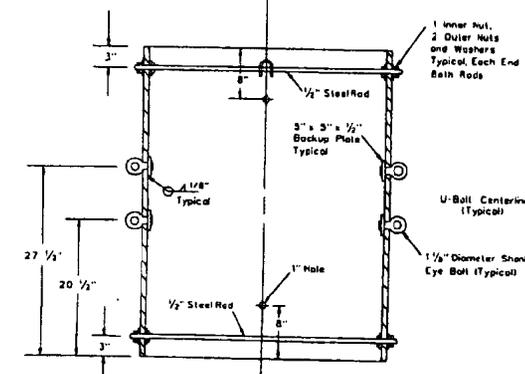


CYLINDER WALL THICKNESS SCHEDULE

Cyl. No.	Thickness
1	1/8"
2	3/16"
3	1/4"
4	1/4"
5	1/4"
6	5/16"
7	3/8"
8	1/4"



NOTE: All Cylinders Are 48" Long and 36" Outside Diameter

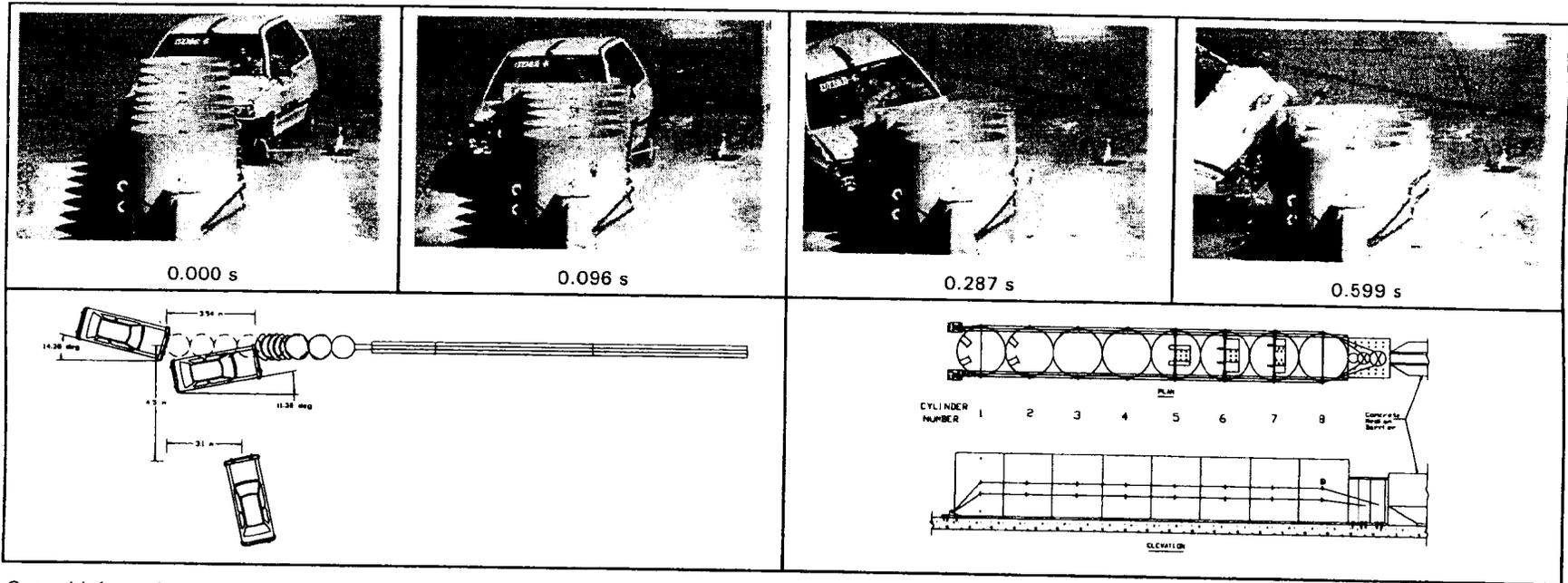


STANDARD SHEET
CONNECTICUT DEPARTMENT OF TRANSPORTATION
NARROW CONNECTICUT IMPACT - ATTENUATION SYSTEM
CYLINDER FABRICATION DETAILS

REVISIONS		Designed by	John F. Corcoran, II	Drawn	1/2/88
NO.	DATE	DESCRIPTION	Checked by	Michael E. Ryan	Date
1	3/81	U-Bolts Eye-Bolts Lifting Rings	Designed by	KEC C. Lopez	Date
2	1/88	Welds & Gas Members	Approved by		Date
3	1/88	Galvanized Coating	Approved by		Date

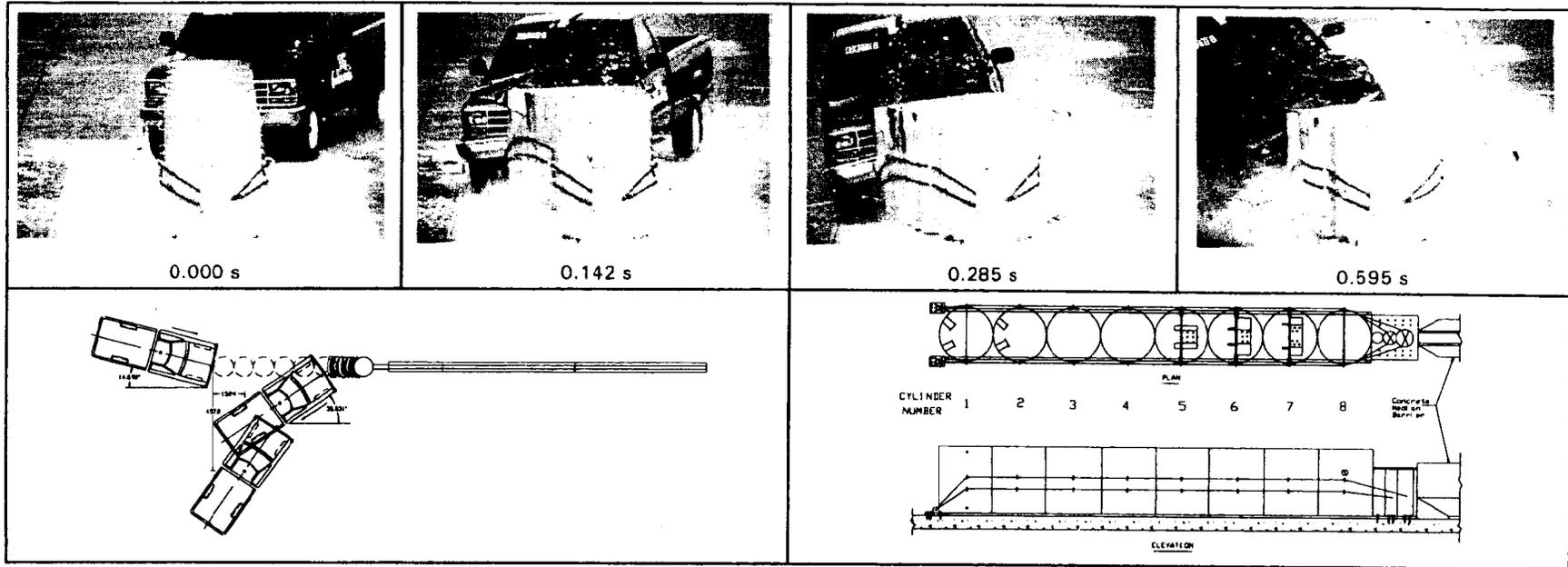
Scale: NOT TO SCALE

1804-B1



33	General Information Test Agency Texas Transportation Institute Test No. 404231-2 Date 12/15/97 Test Article Type Crash Cushion Name or Manufacturer Narrow Conn. Imp. Attn. System Installation Length (m) 7.3 Size and/or dimension and material of key elements 8 each 914 O.D. x 1219 mm tall steel pipe cylinders of various wall thickness Soil Type and Condition Concrete pavement, dry Test Vehicle Type Production Designation 820C Model 1990 Ford Festiva Mass (kg) Curb 810 Test Inertial 820 Dummy 75 Gross Static 895	Impact Conditions Speed (km/h) 98.92 Angle (deg) 14.38 Exit Conditions Speed (km/h) 12.59 Angle (deg) 11.38 Occupant Risk Values Impact Velocity (m/s) x-direction 9.98 y-direction 2.77 Ridedown Accelerations (g's) x-direction -12.44 y-direction -3.17 Max. 0.050-s Average (g's) x-direction -12.74 y-direction -2.07 z-direction -2.13	Test Article Deflections (m) Dynamic 3.94 Permanent 3.44 Vehicle Damage Exterior VDS 11LFQ4 CDC 11LFEW3 Maximum Exterior Vehicle Crush (mm) 310 Interior OCDI LF000000 Max. Occ. Compart. Deformation (mm) 8 Post-Impact Behavior (during 1.0 s after impact) Max. Yaw Angle (deg) -109 Max. Pitch Angle (deg) -8 Max. Roll Angle (deg) 29
----	--	---	---

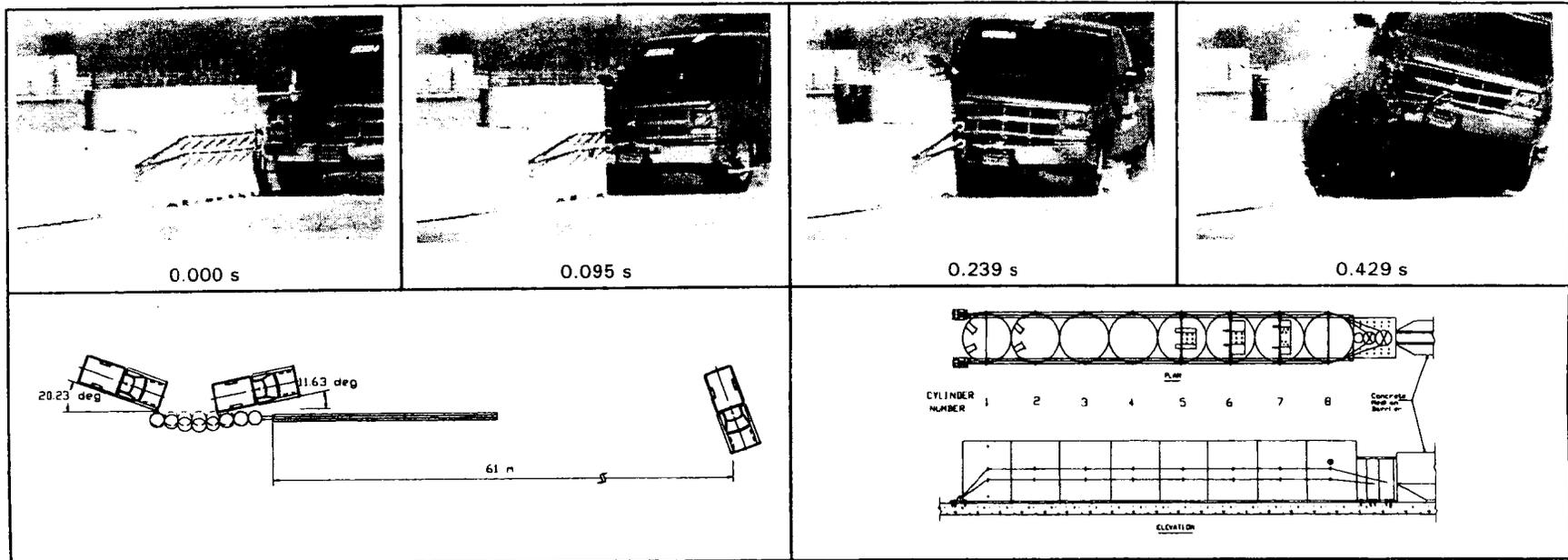
Figure 12. Summary of results for test 404231-2.



33

General Information		Impact Conditions		Test Article Deflections (m)	
Test Agency	Texas Transportation Institute	Speed (km/h)	99.25	Dynamic	2.27
Test No.	404231-1	Angle (deg)	14.69	Permanent	2.12
Date	10/28/97	Exit Conditions		Vehicle Damage	
Test Article		Speed (km/h)	10.86	Exterior	
Type	Crash Cushion	Angle (deg)	35 behind	VDS	12FD4
Name	Narrow Conn. Imp. Atten. System	Occupant Risk Values		CDC	12FDEW3
Installation Length (m)	7.35	Impact Velocity (m/s)		Maximum Exterior	
Size and/or dimension and material of key elements	8 each 914 O.D. x 1219 mm tall steel pipe cylinders of various wall thickness	x-direction	8.46	Vehicle Crush (mm)	260
Soil Type and Condition	Concrete pavement, dry	y-direction	2.99	Interior	
Test Vehicle		Ridedown Accelerations (g's)		OCDI	FS000000
Type	Production	x-direction	-12.33	Max. Occ. Compart.	
Designation	2000P	y-direction	-5.94	Deformation (mm)	0
Model	1992 Chevrolet 2500 pickup	Max. 0.050-s Average (g's)		Post-Impact Behavior	
Mass (kg) Curb	2033	x-direction	-10.38	(during 1.0 s after impact)	
Test Inertial	2000	y-direction	-2.71	Max. Yaw Angle (deg)	-72
Dummy	76	z-direction	2.43	Max. Pitch Angle (deg)	-7
Gross Static	2076			Max. Roll Angle (deg)	19

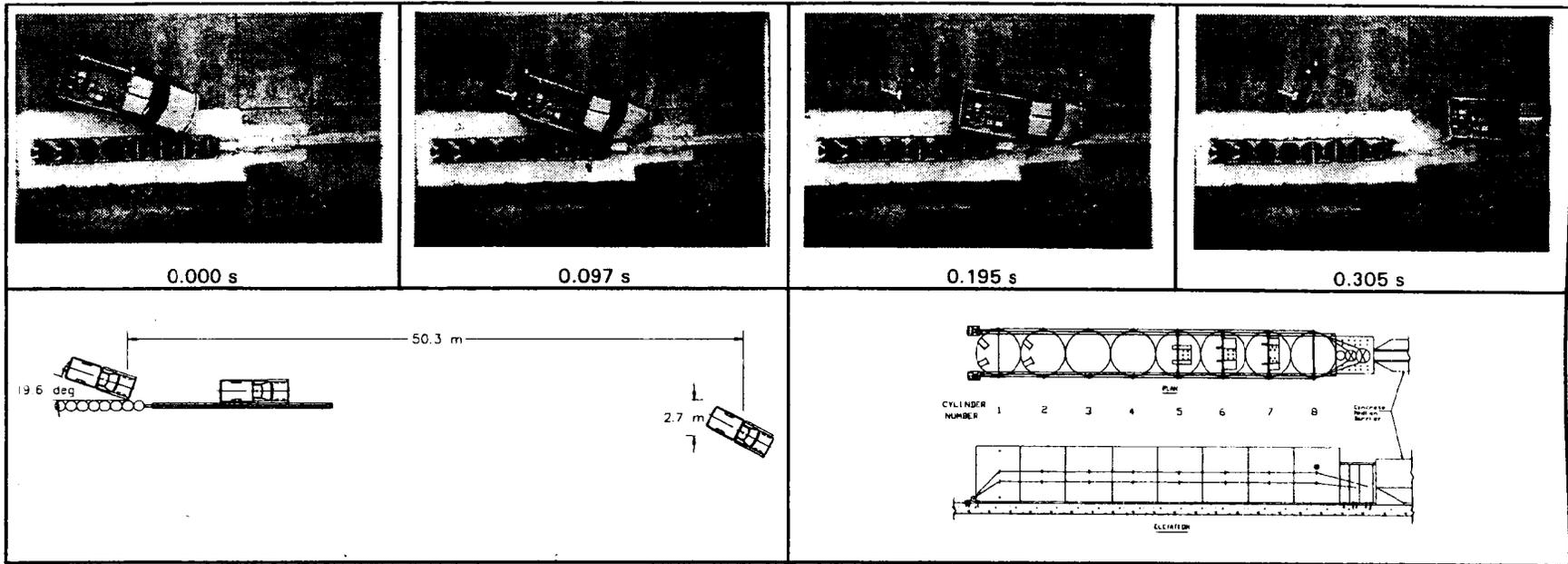
Figure 12. Summary of results for test 404231-1.



33

General Information		Impact Conditions		Test Article Deflections (m)	
Test Agency	Texas Transportation Institute	Speed (km/h)	97.15	Dynamic	0.64
Test No.	404231-3	Angle (deg)	20.23	Permanent	0.44
Date	12/16/97				
Test Article		Exit Conditions		Vehicle Damage	
Type	Crash Cushion	Speed (km/h)	61.45	Exterior	
Name	Narrow Conn. Imp. Atten. System	Angle (deg)	11.63	VDS	01RFQ5
Installation Length (m)	7.31			CDC	01FREK3 & 01REW3
Size and/or dimension and material of key elements	8 each 914 O.D. x 1219 mm tall steel pipe cylinders of various wall thickness	Occupant Risk Values		Maximum Exterior Vehicle Crush (mm)	550
Soil Type and Condition	Concrete Pavement, dry	Impact Velocity (m/s)		Interior	
Test Vehicle		x-direction	7.69	OCDI	FS0103000
Type	Production	y-direction	5.37	Max. Occ. Compart. Deformation (mm)	39
Designation	2000P	Ridedown Accelerations (g's)		Post-Impact Behavior (during 1.0 s after impact)	
Model	1994 Chevrolet 2500 pickup	x-direction	-17.68	Max. Yaw Angle (deg)	-25
Mass (kg) Curb	1885	y-direction	-19.47	Max. Pitch Angle (deg)	7
Test Inertial	2000	Max. 0.050-s Average (g's)		Max. Roll Angle (deg)	-11
Dummy	76	x-direction	-8.52		
Gross Static	2076	y-direction	-7.57		
		z-direction	7.35		

Figure 12. Summary of results for test 404231-3.



33

General Information

Test Agency Texas Transportation Institute
 Test No. 404231-5
 Date 06/08/98

Test Article

Type Crash Cushion
 Name or Manufacturer Mod. Narrow Conn. Imp. Atten. Sys
 Installation Length (m) 7.31
 Material or Key Elements 8 @ 9140.D.x1219mm Tall Steel Pipe
 Cylinders of Various Wall Thickness

Soil Type and Condition

Concrete Pavement, Dry

Test Vehicle

Type Production
 Designation 2000P
 Model 1994 Chevrolet Pickup
 Mass (kg)
 Curb 1891
 Test Inertial 2000
 Dummy 75
 Gross Static 2075

Impact Conditions

Speed (km/h) 100.1
 Angle (deg) 19.6

Exit Conditions

Speed (km/h) 79.6
 Angle (deg) 1.2

Occupant Risk Values

Impact Velocity (m/s)
 x-direction 7.6
 y-direction 4.7
 Ridedown Accelerations (g's)
 x-direction -9.6
 y-direction -11.23
 Max. 0.050-s Average (g's)
 x-direction -8.0
 y-direction -9.4
 z-direction 5.4

Test Article Deflections (m)

Dynamic 0.24
 Permanent 0.23

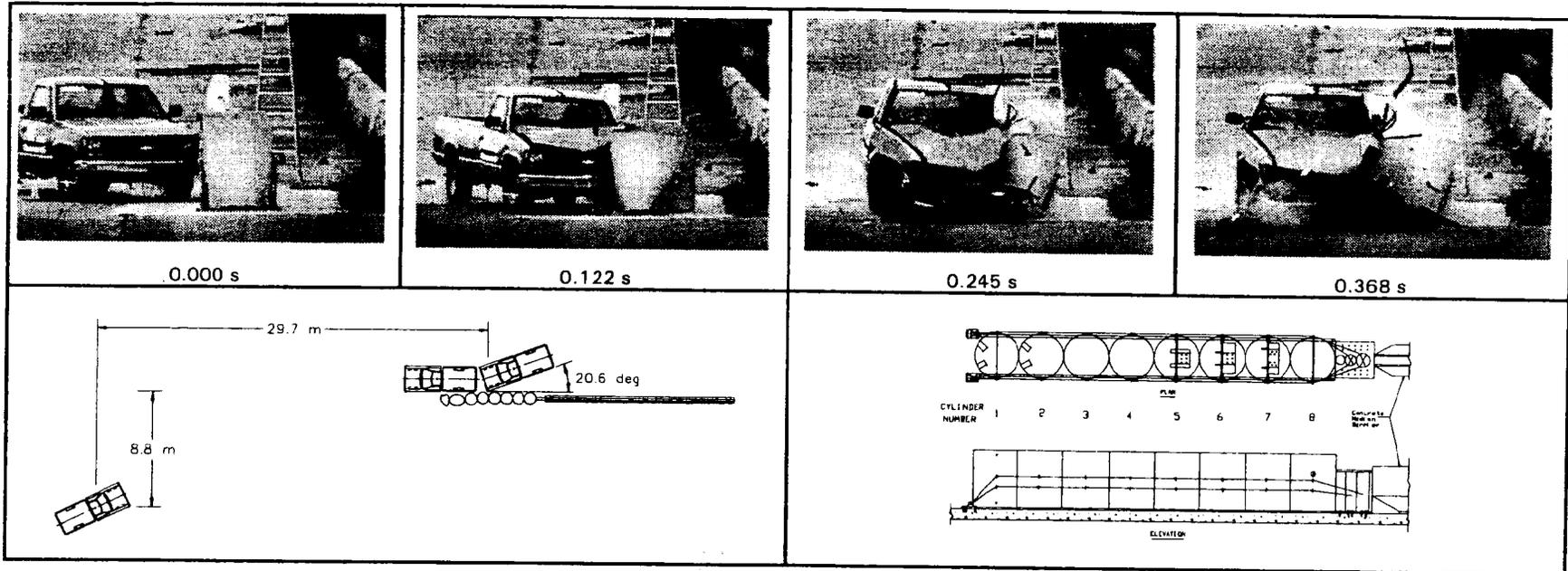
Vehicle Damage

Exterior
 VDS 01RFQ6
 CDC 01RDEW4
 Maximum Exterior
 Vehicle Crush (mm) 600
 Interior
 OCDI RF1210000
 Max. Occ. Compart.
 Deformation (mm) 167

Post-Impact Behavior

(during 1.0 s after impact)
 Max. Yaw Angle (deg) -18
 Max. Pitch Angle (deg) -9
 Max. Roll Angle (deg) -9

Figure 13. Summary of results for test 404231-5, NCHRP Report 350 test 3-38.



33

General Information

Test Agency Texas Transportation Institute
 Test No. 404231-6
 Date 06/09/98

Test Article

Type Crash Cushion
 Name Mod Narrow Conn. Imp. Atten. System
 Installation Length (m) 7.31
 Material or Key Elements 8 @ 9140.D.x1219mm Tall Steel Pipe
 Cylinders of Various Wall Thickness
 Soil Type and Condition Concrete Pavement, Dry

Soil Type and Condition

Test Vehicle

Type Production
 Designation 2000P
 Model 1994 Chevrolet 2500 Pickup Truck
 Mass (kg)
 Curb 1883
 Test Inertial 2000
 Dummy 75
 Gross Static 2075

Impact Conditions

Speed (km/h) 99.7
 Angle (deg) 20.6

Exit Conditions

Speed (km/h) 51.1
 Angle (deg) 1.7

Occupant Risk Values

Impact Velocity (m/s)
 x-direction 10.1
 y-direction 6.4
 Ridedown Accelerations (g's)
 x-direction -26.8
 y-direction 20.3
 Max. 0.050-s Average (g's)
 x-direction -14.0
 y-direction 8.0
 z-direction 7.7

Test Article Deflections (m)

Dynamic 0.51
 Permanent 0.23

Vehicle Damage

Exterior
 VDS 11LD6
 CDC 11LDEW5
 Maximum Exterior
 Vehicle Crush (mm) 1080
 Interior
 OCDI LF3130000
 Max. Occ. Compart.
 Deformation (mm) 340 *

Post-Impact Behavior

(during 1.0 s after impact)
 Max. Yaw Angle (deg) 28
 Max. Pitch Angle (deg) -4
 Max. Roll Angle (deg) -5

Figure 13. Summary of results for test 404231-6, NCHRP Report 350 test 3-39.

* Note: unacceptable passenger compartment deformation