June 16, 1998

Refer to: HNG-14

John F. Carney, III, Ph.D., P.E.
Provost and Vice President for
Academic Affairs
Worcester Polytechnic Institute
100 Institute Road
Worcester, Massachusetts 01609-2280

Dear Dr. Carney:

On March 20 you sent information on the Wide REACT crash cushion addressed to the Director, Office of Engineering requesting that the Federal Highway Administration (FHWA) accept this device for use on the National Highway System (NHS) at National Cooperative Highway Research Program (NCHRP) Report 350 test level 3 (TL-3). Included with your request were copies of the Texas Transportation Institute's March 1998 report entitled "Full-Scale Crash Testing and Evaluation of the Wide REACT System" and video tapes of the tests that were conducted. After members of my staff reviewed your submission, I responded on April 3 that at least two additional tests were recommended because the effect on early tests of design changes made to the Wide REACT as the testing continued was questionable and because we believed that at least one critical test was not run. Specifically, we had recommended that test 3-30 (820-kg car head-on at 100km/h) be re-run and also that test 3-36 (820-kg car at 15 degrees and 100 km/h impacting at the interface of cylinders 2 and 3) be run. On June 9, Mr. Richard Powers of my staff received copies of a Texas Transportation Institute report "NCHRP Report 350 Tests 3-36 and 3-30 of the Wide REACT", dated June 1998, and - by separate correspondence on the same day - your concurrent request for FHWA acceptance of the Wide REACT at TL- 3 based on this additional information.

We noted that when you ran test 3-36 on the original design, the vehicle was not redirected and the occupant impact velocity exceeded the maximum allowable value of 12 m/s. As a result, you modified the wall thicknesses of several cylinders in the tested array and re-ran the test with passing results. You then re-ran test 3-30 using the revised design, and successfully met the appropriate evaluation criteria. As implied in my April 3 response to your initial request, we are now willing to waive test 3-32 based on the results of the two additional tests you ran. We will also accept tests 3-31 and 3-33 with the 2000-kg pickup truck as valid certification tests in spite of subsequent design changes in the Wide REACT. We believe that the added row of cylinders (after test 3-31) and the reduction in the wall thicknesses of several cylinders (after both tests) is unlikely to effect those test results adversely. Likewise, we have reviewed the reported test

results and video tape coverage of test 3-38, as well as the supplemental information provided by Mr. Dean Alberson in his June 11 letter to Mr. Powers, and concluded that the final design changes to the Wide REACT were again unlikely to change the outcome of the earlier test. Summary sheets for each of the tests noted above are contained in Enclosure 1.

The final design of the Wide REACT, including the specified wall thicknesses of each cylinder in the array, is shown on Enclosure 2. The Wide REACT is intended to shield rigid, vertical-faced structures up to 2.75 meters in width. We note the system uses the same basic components as the narrow REACT but consists of two parallel columns of polyethylene cylinders set on support anchor tracks and contained by four redirecting cables on the outside of each column. A rigid strut spans the system between rows four and five to transfer loads to the opposite-side cables when the Wide REACT is impacted on the side.

Based on our review of the test results and final design details, we agree that the Wide REACT, as anchored and tested, satisfies the evaluation criteria for an NCHRP Report 350 TL-3 crash cushion. It may be used on the National Highway System (NHS) when such use is requested by a State highway agency. Because it is a proprietary device, its use on Federal-aid projects, except exempt, non-NHS projects, remains subject to the conditions listed in Title 23, Code of Federal Regulations, Section 635.411, copies of which have previously been sent to you. As stated in my April 3 response to your original request, additional testing on the rear transition may be needed if the Wide REACT is intended for use at sites where reverse-direction impacts are likely.

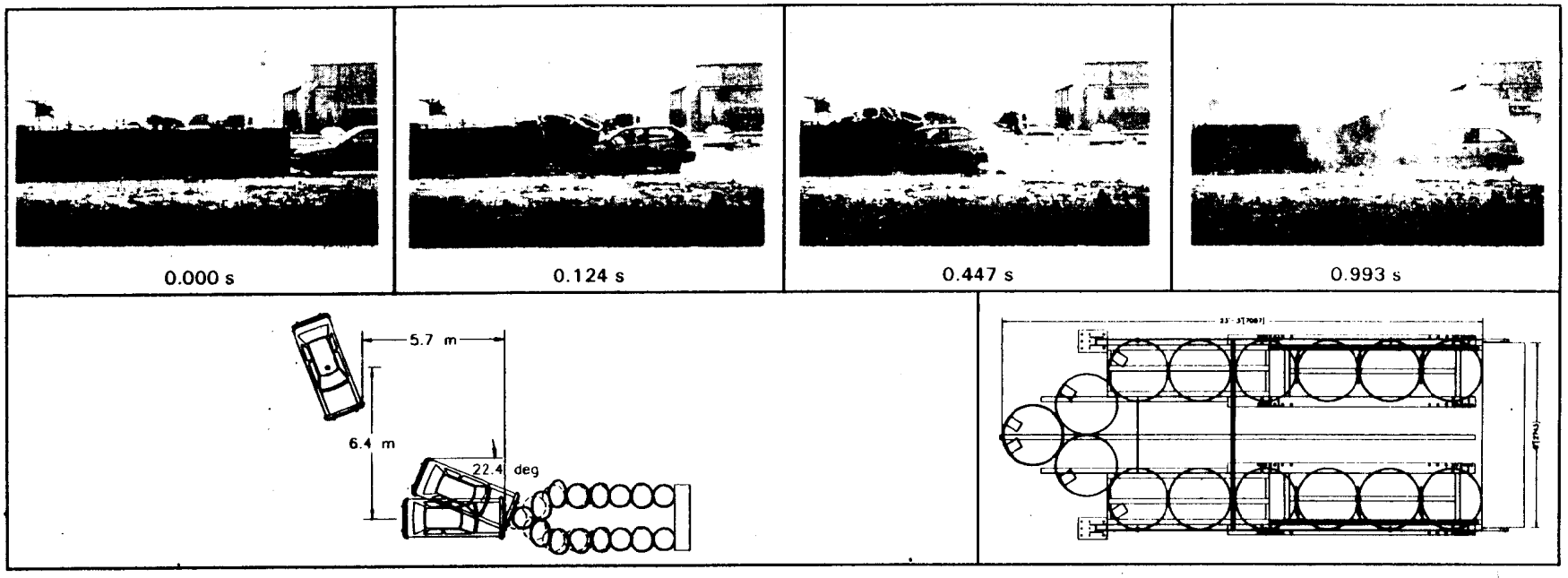
Please call Mr. Powers at (202) 366-1320 if you have any questions regarding this action.

Sincerely yours,

(original signed by Dwight A. Horne)

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

2 Enclosures
Acceptance Letter CC-50



General information
- Test Agency . . . . . Texas Transportation Institute
- Test No. 400001-WDR11
- Date 05/15/98

Test Article
- Type . . . . . Crash Cushion
- Name or Manufacturer . . . . Wide REACT
- Installation Length (m) . . . . 7.1 m
- Material or Key Elements . . Fifteen polyethylene cylinders of various densities

Soil Type and Condition . . . . . 76 mm deep concrete pad, dry

Test Vehicle
- Type . . . . . Production
- Designation 820C
- Model . . . . . 1994 Geo Metro
- Mass (kg) Curb 748
  - Test Inertial 820
  - Dummy 75
  - Gross Static 895

Impact Conditions
- Speed (km/h) 98.2
- Angle (deg) 0

Exit Conditions
- Speed (km/h) 13.4
- Angle (deg) 22.4

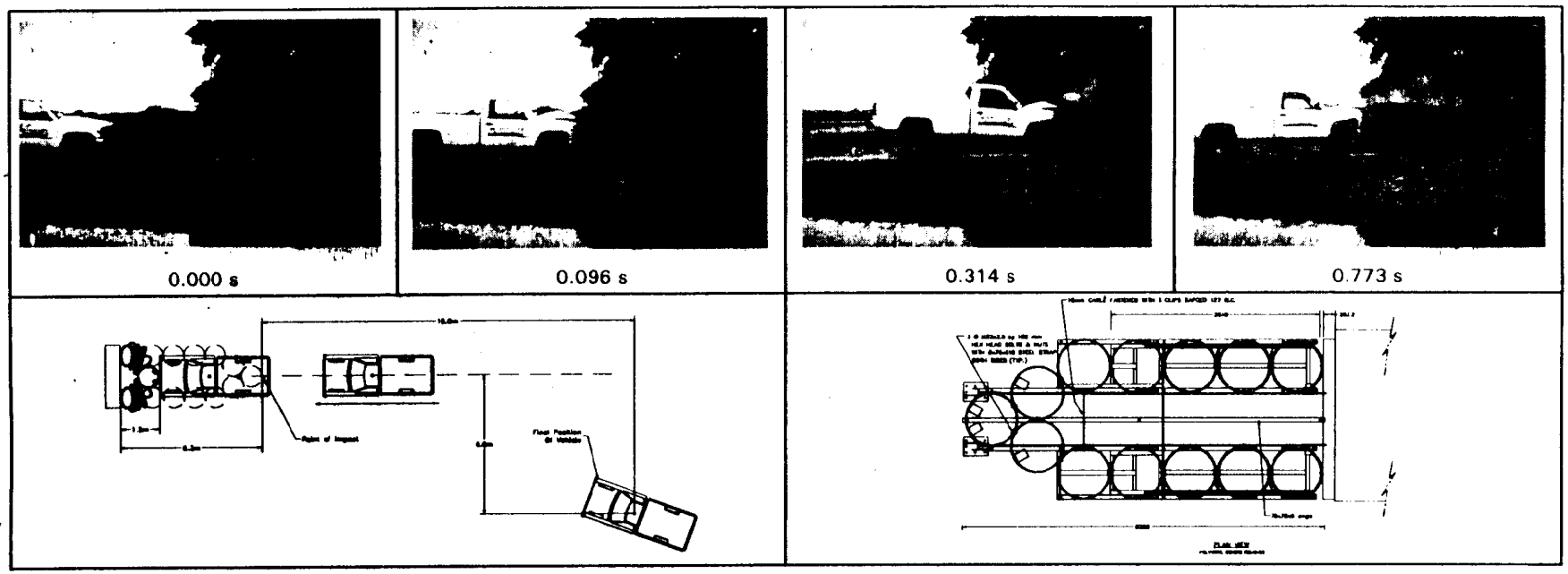
Occupant Risk Values
- Impact Velocity (m/s)
  - x-direction 8.9
  - y-direction . . . . . No contact
- THIV (km/h) 32.1
- Ridedown Accelerations (g's)
  - x-direction . . . . . -18.9
  - y-direction . . . . . No contact
- PHD (g's) 37.4
- ASI 1.0
- Max. 0.050-s Average (g's)
  - x-direction . . . . . -11.9
  - y-direction . . . . . -2.3
  - z-direction . . . . . -3.6

Test Article Deflections (m)
- Dynamic 3.81
- Permanent 0.65

Vehicle Damage
- Exterior
  - VDS 12FD3
  - CDC 12FDEW3
- Maximum Exterior Vehicle Crush (mm) 160
- Interior
  - OCDI FS0000000
- Max. Occ. Compart. Deformation (mm) 15

Post-Impact Behavior (during 1.0 s after impact)
- Max. Yaw Angle (deg) 7
- Max. Pitch Angle (deg) . . . . -4
- Max. Roll Angle (deg) 5

Figure 18. Summary of results for test 400001-WDR11, NCHRP Report 350 test 3-30.



General Information
- Test Agency ..... Texas Transportation Institute
- Test No. 400001-WDR1
- Date 05/20/97

Test Article
- Type ..... Crash Cushion
- Name ..... Wide REACT
- Installation Length (m) 6.3
- Size and/or dimension and material of key elements ..... Thirteen polyethylene cylinders of various densities

Soil Type and Condition ..... 76 mm deep concrete pad, dry

Test Vehicle
- Type ..... Production
- Designation 2000P
- Model ..... 1991 Chevrolet 2500 pickup
- Mass (kg) Curb 2020
  - Test Inertial 2000
  - Dummy ..... No dummy
  - Gross Static 2000

Impact Conditions
- Speed (km/h) 96.48
- Angle (deg) ..... 0 - cntr/cntr

Exit Conditions
- Speed (km/h) 23.09
- Angle (deg) 0

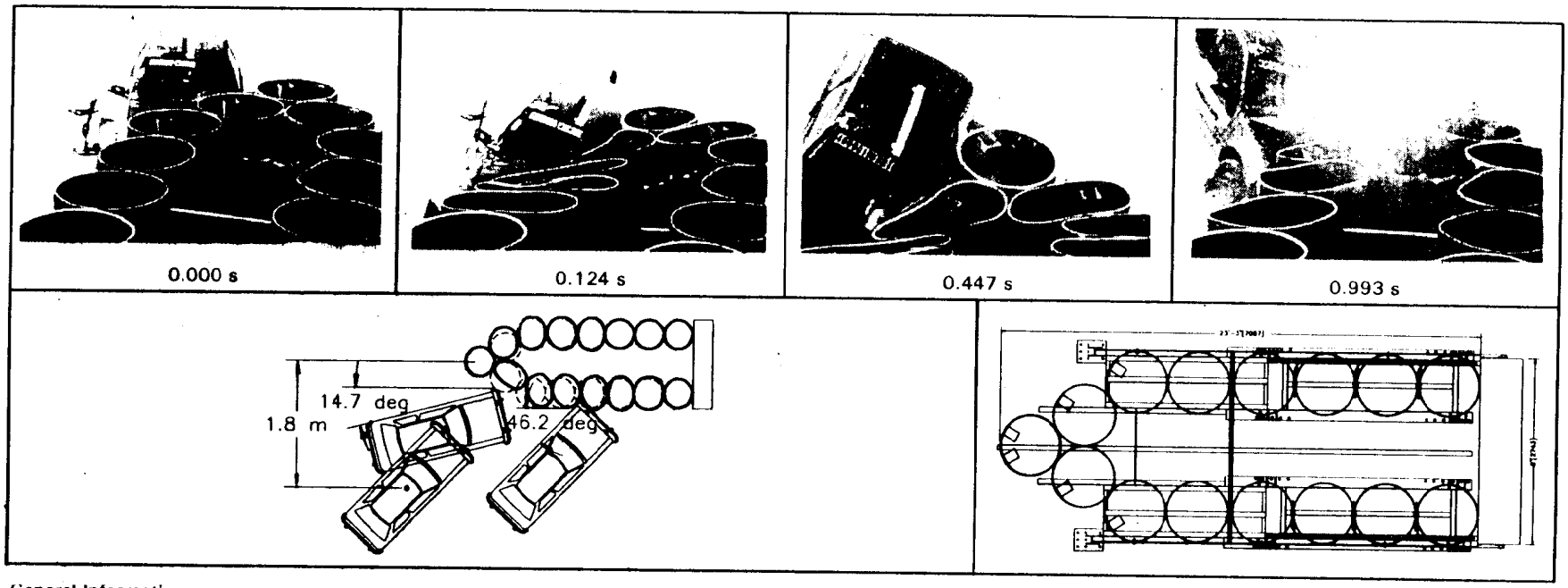
Occupant Risk Values
- Impact Velocity (m/s)
  - x-direction 7.93
  - y-direction ..... No contact
- Ridedown Accelerations (g's)
  - x-direction ..... -18.26
  - y-direction ..... N/A
- Max. 0.050-s Average (g's)
  - x-direction ..... -14.57
  - y-direction ..... -1.13
  - z-direction 3.31

Test Article Deflections (m)
- Dynamic 4.42
- Permanent 0.66

Vehicle Damage
- Exterior
  - VDS 12FD3
  - CDC 12FDEW3
- Maximum Exterior Vehicle Crush (mm) 340
- Interior
  - OCDI FS0000000
- Max. Occ. Compart. Deformation (mm) 0

Post-Impact Behavior (during 1.0 s after impact)
- Max. Roll Angle (deg) .... -8.5
- Max. Pitch Angle (deg) 5.2
- Max. Yaw Angle (deg) .... -1.2

Figure 13. Summary of results for test 400001-WDR1.



General Information
- Test Agency ..... Texas Transportation Institute
- Test No. 400001-WDR10
- Date 04/22/98

Test Article
- Type ..... Crash Cushion
- Name or Manufacturer .... Wide REACT
- Installation Length (m) .... 7.1 m
- Material or Key Elements .. Fifteen polyethylene cylinders of various densities
- Soil Type and Condition ..... 76 mm deep concrete pad, dry

Test Vehicle
- Type ..... Production
- Designation 820C
- Model ..... 1993 Geo Metro
- Mass (kg) Curb 744
  - Test Inertial 820
  - Dummy 76
  - Gross Static 896

Impact Conditions
- Speed (km/h) 97.8
- Angle (deg) 14.7

Exit Conditions
- Speed (km/h) 19.6
- Angle (deg) 46.2

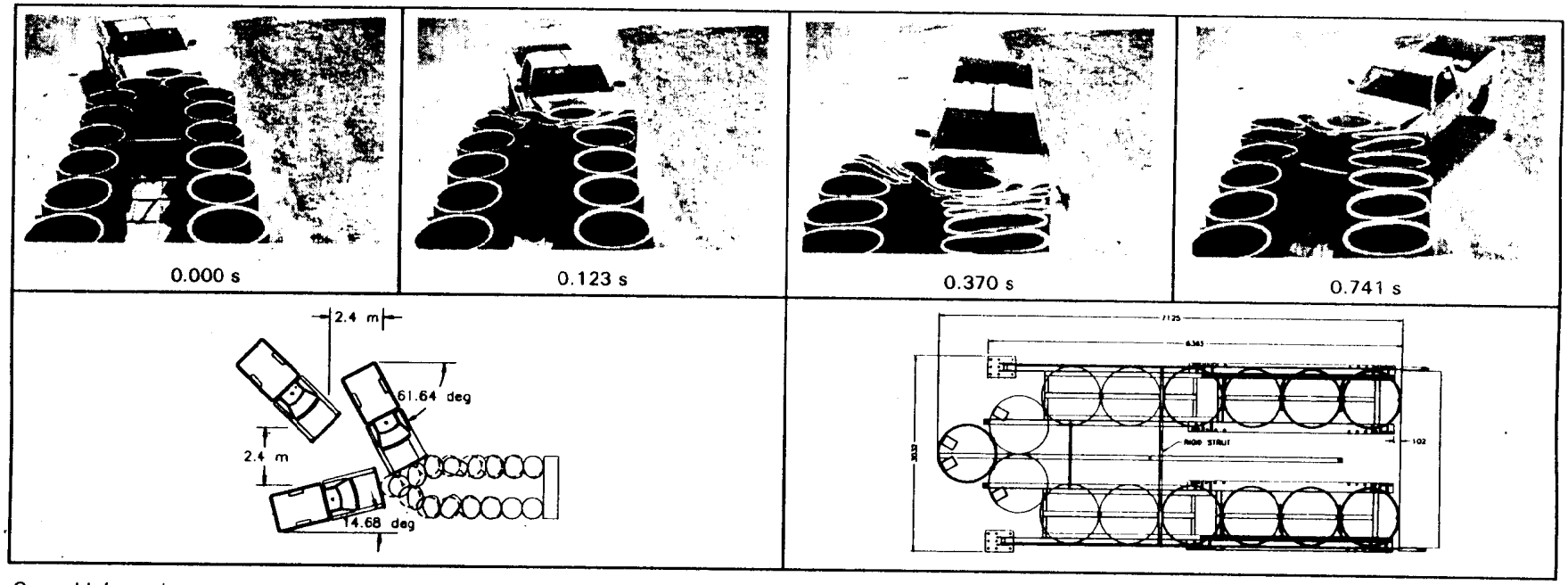
Occupant Risk Values
- Impact Velocity (m/s)
  - x-direction 12.0
  - y-direction 3.8
- THIV (km/h) 44.8
- Ridedown Accelerations (g's)
  - x-direction ..... -9.7
  - y-direction 2.8
- PHD (g's) 9.3
- ASI 1.2
- Max. 0.050-s Average (g's)
  - x-direction ..... -13.2
  - y-direction 4.4
  - z-direction ..... -2.4

Test Article Deflections (m)
- Dynamic 3.39
- Permanent 0.43

Vehicle Damage
- Exterior
  - VDS 12FD3
  - CDC 12FDEW3
- Maximum Exterior Vehicle Crush (mm) 165
- Interior
  - OCDI FS0000100
- Max. Occ. Compart. Deformation (mm) 44

Post-Impact Behavior (during 1.0 s after impact)
- Max. Yaw Angle (deg) .... -31
- Max. Pitch Angle (deg) .... -28
- Max. Roll Angle (deg) .... -30

Figure 10. Summary of results for test 400001-WDR10, NCHRP Report 350 test 3-36.



General Information
- Test Agency . . . . . Texas Transportation Institute
- Test No. 400001-8
- Date 02/09/98

Test Article
- Type . . . . . Crash Cushion
- Name or Manufacturer . . . . Wide REACT
- Installation Length (m) 7.13
- Size and/or dimension and material of key elements . . . . . Fifteen polyethylene cylinders of various densities
- Soil Type and Condition . . . . . 76 mm deep concrete pad, dry

Test Vehicle
- Type . . . . . Production
- Designation 2000P
- Model . . . . . 1993 Chevrolet 2500 pickup
- Mass (kg) Curb 2091
  - Test Inertial 2000
  - Dummy . . . . . No dummy
  - Gross Static 2000

Impact Conditions
- Speed (km/h) 97.80
- Angle (deg) 14.68

Exit Conditions
- Speed (km/h) 17.11
- Angle (deg) 61.64

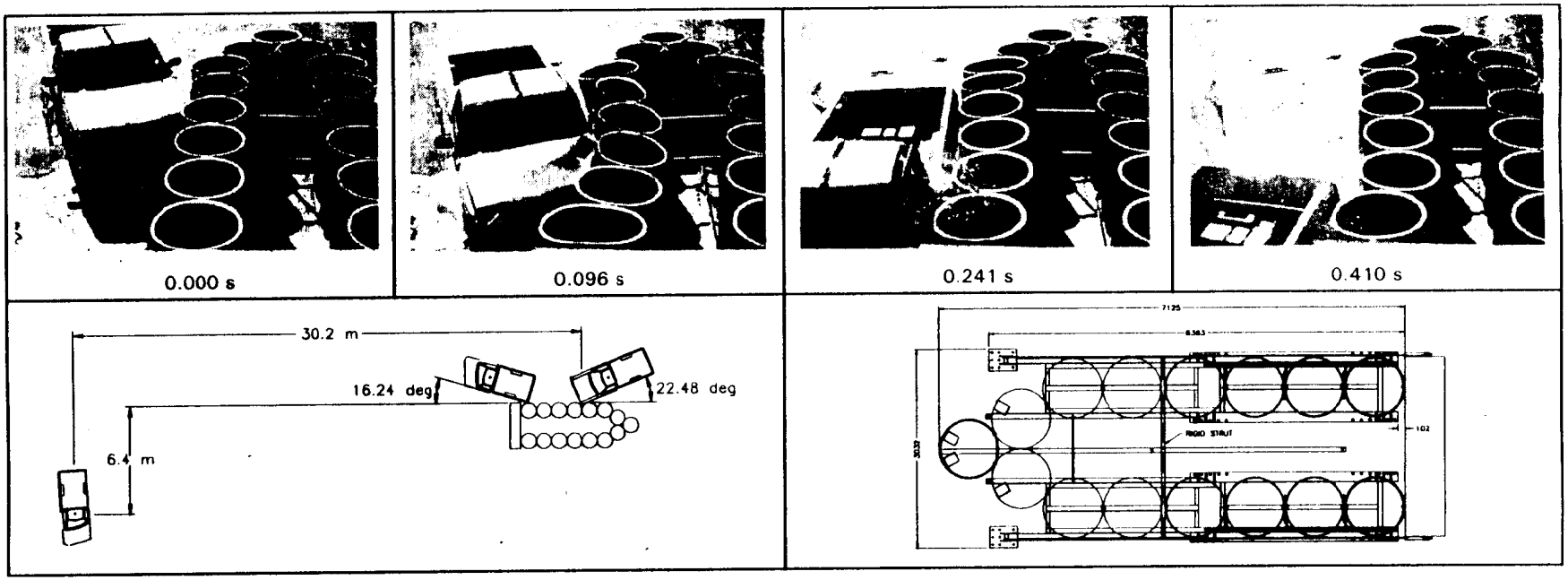
Occupant Risk Values
- Impact Velocity (m/s)
  - x-direction 7.72
  - y-direction 1.91
- Ridedown Accelerations (g's)
  - x-direction . . . . . -16.28
  - y-direction . . . . . -3.52
- Max. 0.050-s Average (g's)
  - x-direction . . . . . -14.15
  - y-direction 2.32
  - z-direction . . . . . -2.70

Test Article Deflections (m)
- Dynamic 4.84
- Permanent 0.73

Vehicle Damage
- Exterior
  - VDS 12FD4
  - CDC 12FDEW3
- Maximum Exterior
  - Vehicle Crush (mm) 370
- Interior
  - OCDI FS0000000
- Max. Occ. Compart. Deformation (mm) 0

Post-Impact Behavior (during 1.0 s after impact)
- Max, Roll Angle (deg) . . . . -8.7
- Max. Pitch Angle (deg) . . . . -9.0
- Max. Yaw Angle (deg) 65.8

Figure 37. Summary of results for test 400001-WDR8.



General Information

Test Agency	Texas Transportation Institute
Test No.	400001-7
Date	01/16/98

Test Article

Type	Crash Cushion
Name or Manufacturer	Wide REACT
Installation Length (m)	7.13
Size and/or dimension and material of key elements	Fifteen polyethylene cylinders of various densities
Soil Type and Condition	76 mm deep concrete pad, dry

Test Vehicle

Type	Production
Designation	2000P
Model	1993 Chevrolet 2500 pickup
Mass (kg) Curb	1811
Test Inertial	2000
Dummy	No dummy
Gross Static	2000

Impact Conditions

Speed (km/h)	96.98
Angle (deg)	22.48

Exit Conditions

Speed (km/h)	47.22
Angle (deg)	15.67

Occupant Risk Values

Impact Velocity (m/s)	
x-direction	9.28 (9.32)*
y-direction	7.25 (3.54)
Ridedown Accelerations (g's)	
x-direction	-19.88 (-7.56)
y-direction	17.73 (16.56)
Max. 0.050-s Average (g's)	
x-direction	-11.44 (-9.01)
y-direction	10.16 (5.32)
z-direction	6.49

* data from rear accelerometers in parenthesis

Test Article Deflections (m)

Dynamic	0.12
Permanent	0.95

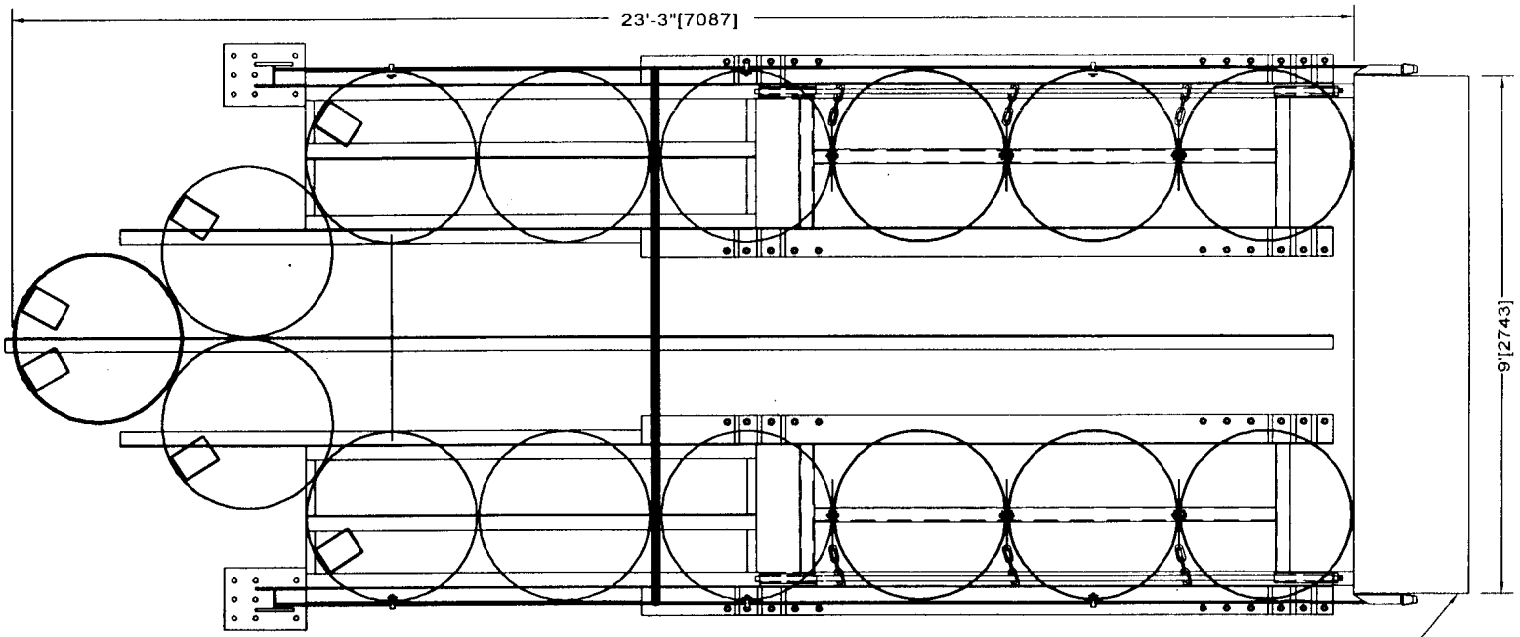
Vehicle Damage

Exterior	
VDS	11LFQ5
CDC	11FLEK4 &11LYEW3
Maximum Exterior Vehicle Crush (mm)	800
Interior	
OCDI	LF0112000
Max. Occ. Compart. Deformation (mm)	54

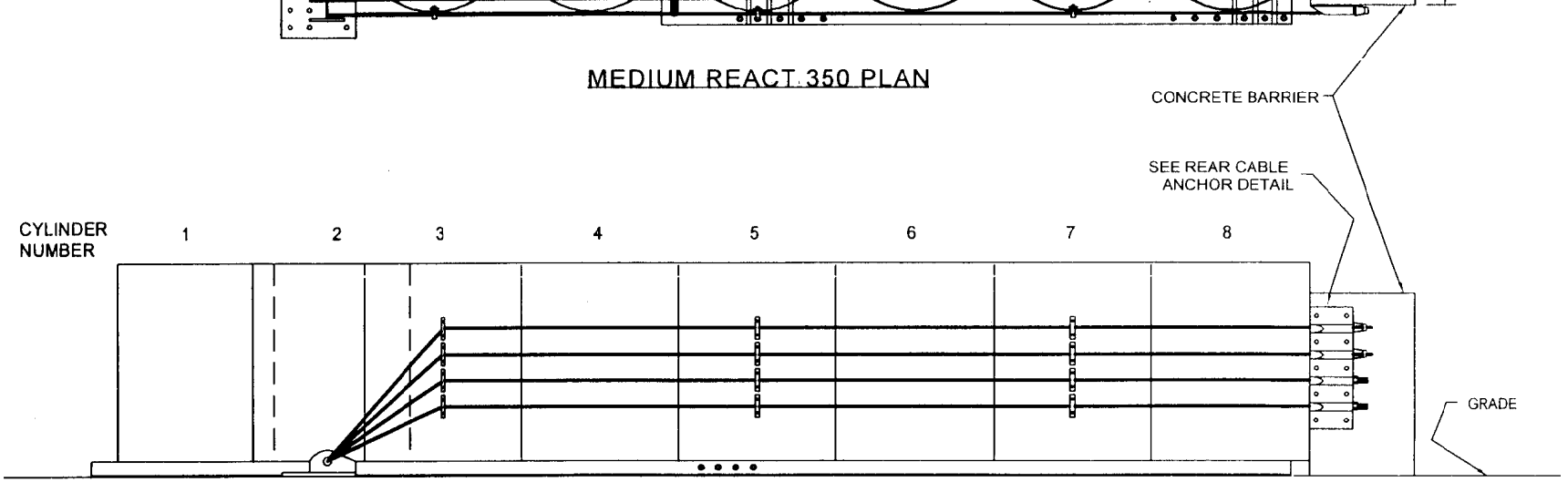
Post-Impact Behavior (during 1.0 s after impact)

Max. Roll Angle (deg)	-5.6
Max. Pitch Angle (deg)	-2.3
Max. Yaw Angle (deg)	39.2

Figure 29. Summary of results for test 400001-WDR7.

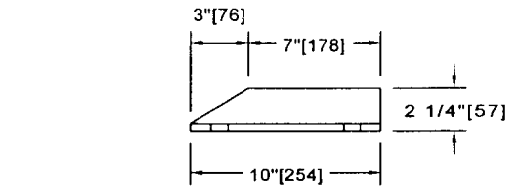


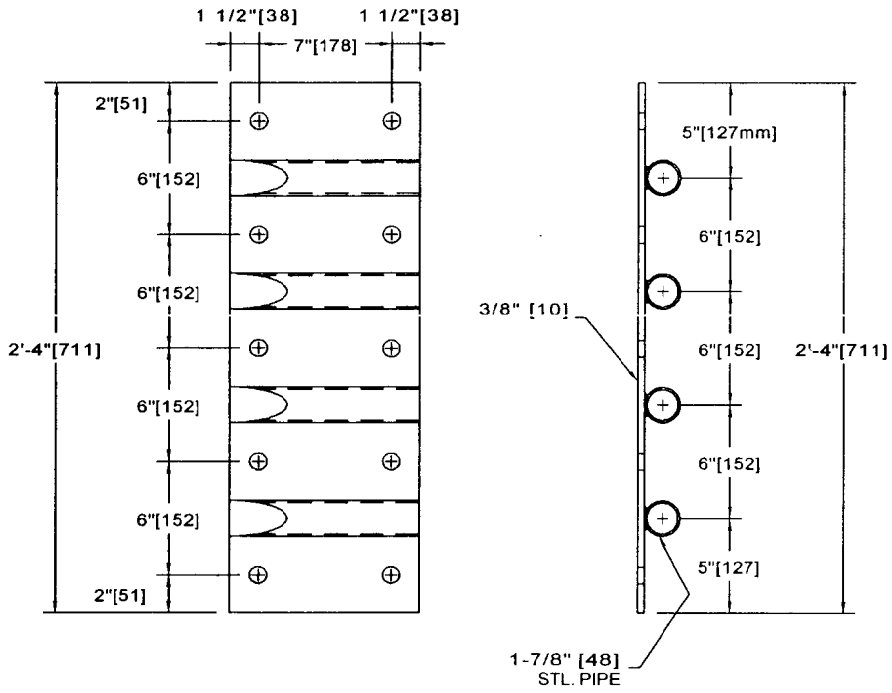
MEDIUM REACT 350 PLAN



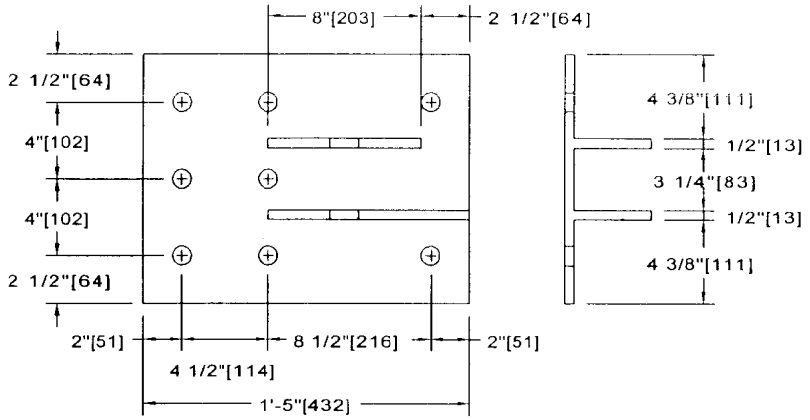
MEDIUM REACT 350 ELEVATION

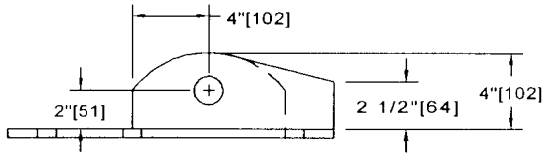
U.S. PATENT No. 5403112		DATE: 4/4/95	ROADWAY SAFETY SERVICE, INC. 1050 RAND ROAD WAUCONDA, IL 60084	
PREPARED	C. KARPATHY	2/24/98	PRODUCED: SAFETY QUEST, INC. 308 UNIVERSITY DRIVE E. COLLEGE STATION, TX 77840	
ENGINEER	L. BULLARD	2/10/98		
	D. ALBERSON	2/10/98	TITLE: REACT 350	
REVISED	C. KARPATHY	6/11/98		
SCALE: 1 = 40	SHEET: 1 OF 3		SIZE: A	DESIGN WIDTH: 7'-9" - 10'-0" REV.



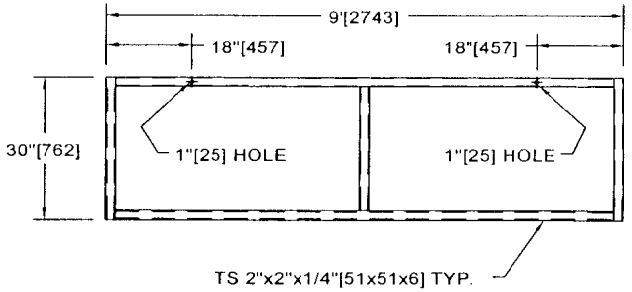


SIDE CABLE ANCHOR PLATE DETAIL





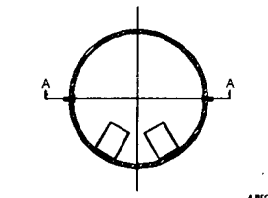
FRONT PLATE ANCHOR DETAIL

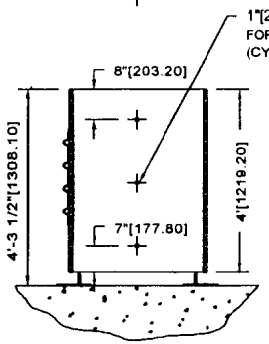


RIGID STRUT DETAIL

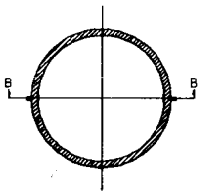
(SCALE 1/4X)

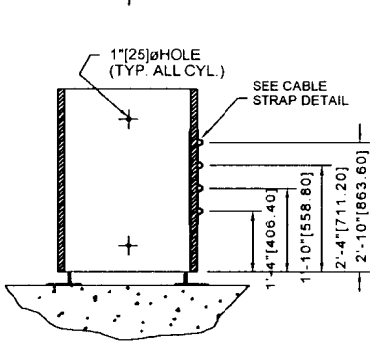
U.S. PATENT No. 5403112		DATE: 4/4/95	ROADWAY SAFETY SERVICE, INC. 1050 RAND ROAD WAUCONDA, IL 60084
PREPARED	C. KARPATHY	5/27/98	PRODUCED: SAFETY QUEST, INC. 505 UNIVERSITY DRIVE E COLLEGE STATION, TX 77840
ENGINEER	L. BULLARD	2/10/98	
	D. ALBERSON	2/10/98	TITLE: REACT 350
REVISED	C. KARPATHY	6/11/98	
SCALE: 1 = 10	SHEET: 3 OF 3		SIZE: A / DESIGN WIDTH: / REV.





SECTION A-A

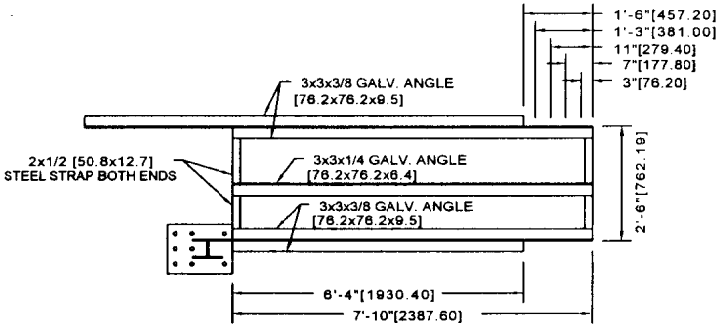




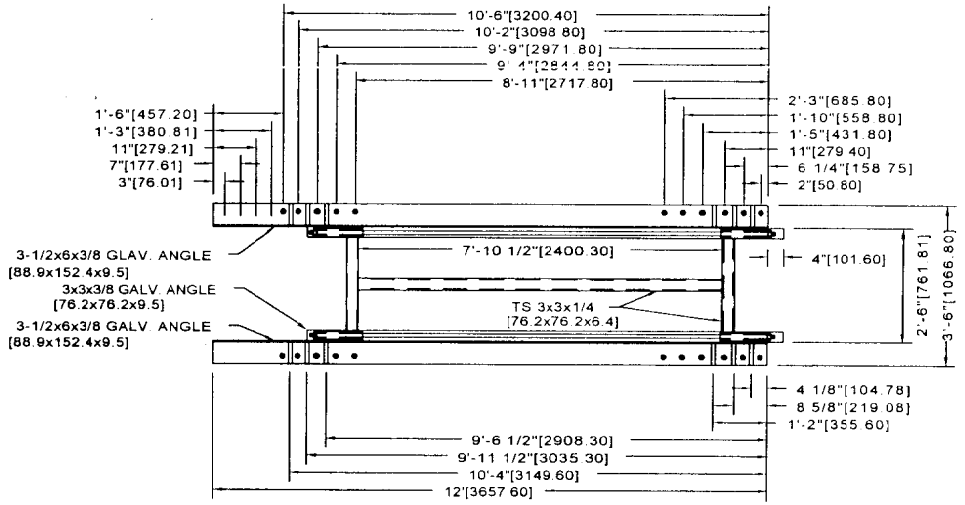
SECTION B-B

WALL THICKNESS SCHED.
(REACT 350.8)

CYL. No.	O.D	THICKNESS
1	36	1.0(25mm)
2	36	0.6(15mm)
3	36	0.6(15mm)
4	36	0.6(15mm)
5	36	0.6(15mm)
6	36	1.0(25mm)
7	36	1.2(30mm)
8	36	1.5(37mm)



FRONT SECTION OF BASE TRACK



REAR SECTION OF BASE TRACK

U.S. PATENT No. 5403112		DATE 4/4/95	ROADWAY SAFETY SERVICE, INC. 1050 RAND ROAD WAUCONDA, IL 60084	
PREPARED	C. KARPATHY	2/24/98	PRODUCED	SAFETY QUEST, INC. 505 UNIVERSITY DRIVE E COLLEGE STATION, TX 77840
ENGINEER	L. BULLARD	2/10/98		
	D. ALBERSON	2/10/98	TITLE	REACT 350
REVISED	C. KARPATHY	6/11/98		
SCALE: 1 = 50	SHEET: 2 OF 3		SIZE: A	DESIGN WIDTH: 7'-9" - 10'-0" REV.