DOT 294

AETL

APPROVED ENGINEERING TEST LABORATORIES / 1536 EAST VALENCIA / FULLERTON, CALIFORNIA 92631 / TEL. (714) 879-6110

A NATIONAL TECHNICAL SERVICES COMPANY

REPORT NO. 301-AETL-81-031-971-3882-31

NEW VEHICLE ASSESSMENT AND STANDARDS ENFORCEMENT INDICANT TESTING

FMVSS 301-75

TOYO KOGYO COMPANY, LTD.
1981 MAZDA GLC CUSTOM - 5 DOOR HATCHBACK
NHTSA 810504

APPROVED ENGINEERING TEST LABORATORIES
1536 EAST VALENCIA DRIVE
FULLERTON, CALIFORNIA 92631

JANUARY 1981

FINAL REPORT

PREPARED FOR

U. S. DEPARTMENT OF TRANSPORTATION
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION
- ENFORCEMENT -
OFFICE OF VEHICLE SAFETY COMPLIANCE
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Approved by D. J. Dalrymple

Date 17 February 1981

Report Accepted by:

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3/16/81
Date

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15. Supplementary Notes

16. Abstract

New Vehicle Assessment and Standards Enforcement Indicant Test to the requirement of FMVSS 301-75 on a 1981 Mazda GLC Custom - 5 Door Hatchback, NHTSA 810504, VIN-JM1BD2416B0500386 was conducted at Approved Engineering Test Laboratories test facility in Fullerton, California.

The moving barrier impact speed was 35.22 mph in the rear (0°) mode. Test date was January 14, 1981, and the ambient temperature was 70°F.

The subject test vehicle appears to comply with all the requirements of FMVSS 301-75.

17. Key Words	18. Distribution Statement
New Vehicle Assessment FMVSS 301-75 - Fuel System Integrity	

19. Security Class. (of this report)	20. Security Class. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	99	

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SECTION 1

1.0 INTRODUCTION

This report contains information regarding a joint program for the Office of Vehicle Safety Compliance (OVSC), Office of Automotive Ratings (OAR), and Research and Development (R&D) for a vehicle assessment and standards enforcement indicant tests of fuel system integrity relative to Federal Motor Vehicle Safety Standard (FMVSS) No. 301-75. This test was performed under Contract Number DOT-HS-9-02273 by Approved Engineering Test Laboratories, 1536 East Valencia Drive, Fullerton, California, in accordance with the Office of Vehicle Safety Compliance (OVSC) Laboratory Procedures (TP212-02).

The specific purpose of this test was to obtain research and vehicle rating data in conjunction with fuel system integrity indicant data, when a vehicle is impacted in excess of the velocity (30 mph) requirements of FMVSS 301-75.

Section 2 contains general test and vehicle information, occupant/vehicle acceleration summary data, while Section 3 contains all compliance related data. Section 4 contains test dummy and vehicle measurements, along with camera positions. Section 5 discusses AETL's test facilities and data acquisition and reduction system.

SECTION 1

Appendix A contains additional photographs not related to vehicle compliance. Appendix B contains the computer generated plots, while Appendix C contains the dummy certification reports if applicable.

1.1 ADMINISTRATIVE DATA

A. References

1. Federal Motor Vehicle Safety Standard No. 301-75 "Fuel System Integrity" as published in the Federal Register, Volume 38, No. 22397, dated August 20, 1973.

2. National Highway Traffic Safety Administration - Office of Vehicle Safety Compliance Laboratory Procedures for Vehicle Assessment and Standards Enforcement Indicant Testing for "Windshield Mounting", FMVSS 212 - "Windshield Zone Intrusion", FMVSS 219 - "Fuel System Integrity", FMVSS 301-75, TP212-02, dated April 4, 1980.

SECTION 1

B. Description of Test Vehicle

1. 1981 Mazda GLC Custom - 5 Door Hatchback
2. Vehicle Identification No.: JM1BD2416B0500386
3. NHTSA No.: 810504
4. Manufactured Date: July 1980
5. GVWR: 2,800 pounds

C. Dates

1. Vehicle Received: October 29, 1980
2. Start of Test: January 12, 1981
3. Completion of Test: January 14, 1981

SECTION 2

SECTION 2

2.0 GENERAL TEST INFORMATION AND SUMMARY DATA

The 1981 Mazda GLC Custom - 5 Door Hatchback was subjected to a rear moving barrier impact and a static rollover maneuver as required by Federal Motor Vehicle Safety Standard No. 301-75.

Two (2) Part 572 test dummies were positioned in each front designated outboard seating position and were restrained by the belt system in the test vehicle. Just prior to the impact event, the driver dummy head was painted with yellow chalk and the passenger dummy head painted with white chalk to provide post-impact visual inspection of possible dummy head contact with interior components during the impact event.

TABLE I

SUMMARY OF TEST CONDITIONS

TEST VEHICLE INFORMATION:

Manufacturer: Toyo Kogyo Company LTD.

Make/Model: Mazda GLC Custom

Body Style: 5 Door Hatchback Model Year: 1981

VIN: JM1BD2416B0500386 Build Date: July 1980

NHTSA No.: 810504 Color: Red

Engine Data: Four (4) Cylinders; 90.9 Cu. In. Displ.

Transmission Data: Five (5) Speed (X) Manual ( ) Automatic

Major Options: Air Condition, AM-FM Radio

VEHICLE ATTITUDE:

Delivered Attitude: LF 25.5 in.; RF 25.5 in.; LR 24.8 in.; RR 25.0 in.

Test Attitude: LF 24.4 in.; RF 24.7 in.; LR 23.7 in.; RR 24.7 in.

VEHICLE TIRE DATA:

Recommended Cold Tire Pressure: Front = 26 psi

(Up to Vehicle Load Capacity) Rear = 26 psi

Recommended Tire Size: 155SR13 Load Range: 950 @ 32 psi

Tires on Vehicle: 155SR13 - w/s/w - Bridgestone

Spare Tire: X Yes; No; Space Saver: X Yes; No

Note: Spare T105/70D14 - Bridgestone (60 psi)

TABLE Ia

SUMMARY OF TEST CONDITIONS (Cont'd)

TEST CONDITIONS:

Date of Test: January 14, 1981 Time of Test: 1423

Ambient Temperature: 70 °F at Impact Area

VEHICLE CAPACITY:

Type of Seats: ____ Bench; X Bucket; ____ Split Bench

Designated Seating Capacity: Front 2
Center 0
Rear 2
Total 4

Cargo: 80 lbs.

Total 680 lbs. (Vehicle Capacity Weight)

GVWR: 2,800 lbs. (Taken From Certification Label)

GAWR: Front 1,700 lbs.; Rear 1,700 lbs.

VEHICLE DELIVERED WEIGHT: (Fuel - 93% of NFC)

Left Front 601 lbs. Left Rear 404 lbs.
Right Front 663 lbs. Right Rear 350 lbs.
Total Front Weight 1,264 lbs. (62.6 % of Total Vehicle Weight)
Total Rear Weight 754 lbs. (37.4 % of Total Vehicle Weight)
Total Delivered Weight 2,018 lbs.

CALCULATED VEHICLE TEST WEIGHT: 2,426 lbs.
(With Required Dummies and 80 lbs. Cargo)

ACTUAL VEHICLE TEST WEIGHT:

Left Front 695 lbs. Left Rear 523 lbs.
Right Front 744 lbs. Right Rear 450 lbs.
Total Front Weight 1,439 lbs. (59.7 % of Total Vehicle Weight)
Total Rear Weight 973 lbs. (40.3 % of Total Vehicle Weight)
Total Test Weight 2,412 lbs.

TABLE Ib

SUMMARY OF TEST CONDITIONS (Cont'd)

TEST FLUID DATA:

Test Fluid Type: Red Stoddard Solvent ; Specific Gravity: 0.764

Kinematic Viscosity: 1.31

Nominal Fuel Capacity: 11.10 gals. (NFC)

Test Volume: 10.32 gals. (92-94% of NFC)

Fuel System Capacity: 11.10 gals.
(Data from Owner's Manual)

Electric Fuel Pump: ____ Yes; X No; Fuel Injection: ____ Yes; X No

Does Electric Fuel Pump Operate with Ignition Switch "On"

And the Engine Not Operating: ____ Yes; ____ No; X N/A

Details of Fuel System: Fuel filler located on the left rear fender above wheel opening recessed behind a hinged door, fuel tank located horizontally between left frame rail and muffler under rear seat cushion floor pan.

VEHICLE TEST CONDITIONS:

Temperature in Occupant Compartment: N/A °F

Temperature of Windshield Glazing/Moulding: N/A °F

VEHICLE CRUSH AND REBOUND:

Overall Length of Test Vehicle: Pre-Test - Left 157.2 in.; Right 157.4 in.

Post-Test - Left 136.7 in.; Right 136.2 in.

Crush: Left 20.5 in.; Right 21.2 in.

Rebound (From Rigid Barrier Only): N/A in.

TABLE III

POST IMPACT SUMMARY

Vehicle 1981 Mazda GLC

NHTSA No. 810504 Test Date January 14, 1981

TYPE OF TEST: [ ] 0° Frontal Impact

[ ] 30° Oblique Impact (Driver/Passenger) Side

[XXX] Rear Impact

REQUIRED IMPACT VELOCITY RANGE: 34.5 to 35.5 mph

IMPACT VELOCITY: (Traps within 5 feet of impact event)

Trap 1 = 35.21 mph

Trap 2 = 35.23 mph

Average 35.22 mph

Actual distance from vehicle rear bumper to barrier face when entering timing trap 52.5 in.

Actual distance from vehicle rear bumper to barrier face when exiting timing trap 28.5 in.

VEHICLE STATIC CRUSH: Driver's Side = 20.5 inches

Passenger's Side = 21.2 inches

Average = 20.85 inches

Crush Details: Rear window shattered, frame buckled over rear suspension, roof buckled over both "B" posts, both dummies made contact with the rear seat back cushion.

VEHICLE REBOUND: (From rigid barrier only)

Driver's Side = N/A inches

Passenger's Side = N/A inches

Average = N/A inches

SECTION 3

SECTION 3

3.0 TEST DATA

The 1981 Mazda GLC Custom - 5 Door Hatchback was subjected to a rear moving barrier impact and a static rollover maneuver as required by Federal Motor Vehicle Safety Standard No. 301-75.

Color motion picture coverage of the impact along with the static rollover test are considered part of the accumulated pertinent data. Where applicable, still photographs are presented in this report; while the motion picture coverage is submitted separately.

TABLE VI

POST IMPACT SUMMARY

FUEL SYSTEM INTEGRITY - FMVSS 301-75

Vehicle 1981 Mazda GLC

NHTSA No. 810504 Test Date January 14, 1981

	Actual	Max. Allow.
Fuel spillage from impact until vehicle motion ceases.	- 0 -	1 ounce
Fuel spillage for 5 minute period following cessation of vehicle motion after impact.	- 0 -	5 ounces
Fuel spillage for next 25 minute period.	- 0 -	1 ounce/ 1 minute
Time duration from impact until start of rollover test periods.	29 minutes	30 minutes

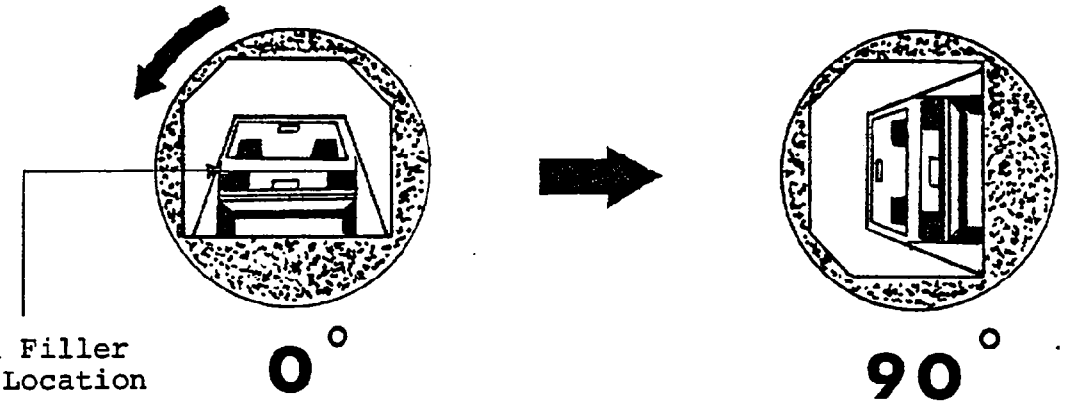
Fuel Spillage Location: Not Applicable

TABLE VII

FUEL SYSTEM INTEGRITY - FMVSS 301-75

STATIC ROLLOVER

Vehicle 1981 Mazda GLC NHTSA No. 810504



	Actual	Max. Allowed
Rollover fixture 90° rotation time	2 min. 15 sec.	1 to 3 Minutes
Fuel spillage during 5 minute period from onset of rotation	- 0 -	5 ounces
Fuel spillage during 6th minute period from onset of rotation	immeasureable	1 ounce
Fuel spillage during 7th minute period from onset of rotation	- 0 -	1 ounce

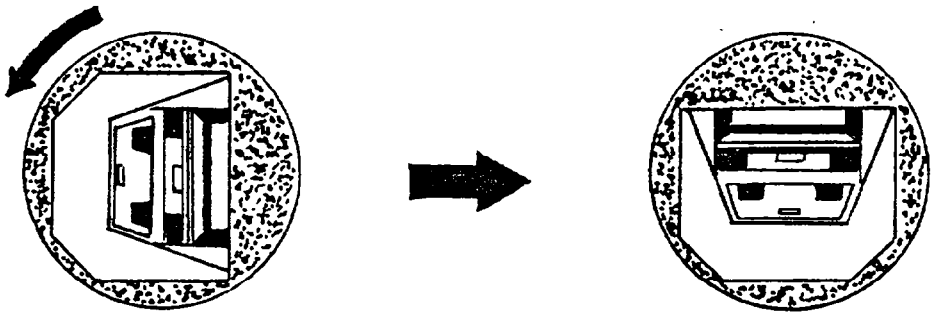
Fuel Spillage Location: Carburetor/Air Cleaner Assembly Area

TABLE VIII

FUEL SYSTEM INTEGRITY - FMVSS 301-75

STATIC ROLLOVER

Vehicle 1981 Mazda GLC NHTSA No. 810504



-	Actual	Max. Allowed
Rollover fixture 90° rotation time	2 min. 18 sec.	1 to 3 Minutes
Fuel spillage during 5 minute period from onset of rotation	- 0 -	5 ounces
Fuel spillage during 6th minute period from onset of rotation	- 0 -	1 ounce
Fuel spillage during 7th minute period from onset of rotation	- 0 -	1 ounce

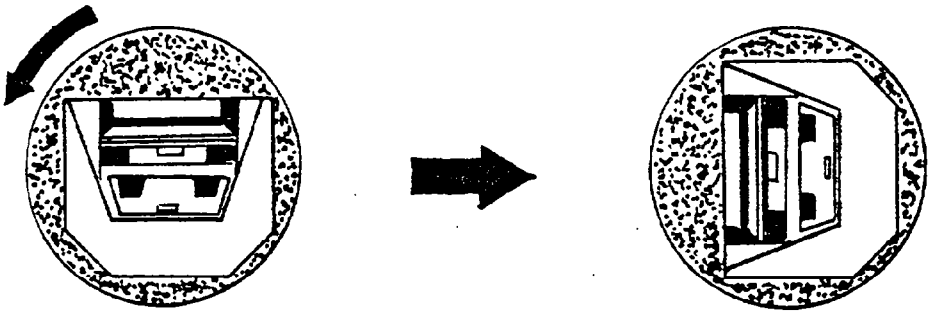
Fuel Spillage Location: Not Applicable

TABLE IX

FUEL SYSTEM INTEGRITY - FMVSS 301-75

STATIC ROLLOVER

Vehicle 1981 Mazda GLC NHTSA No. 810504



	Actual	Max. Allowed
Rollover fixture 90° rotation time	2 min. 14 sec.	1 to 3 Minutes
Fuel spillage during 5 minute period from onset of rotation	immeasureable	5 ounces
Fuel spillage during 6th minute period from onset of rotation	- 0 -	1 ounce
Fuel spillage during 7th minute period from onset of rotation	- 0 -	1 ounce

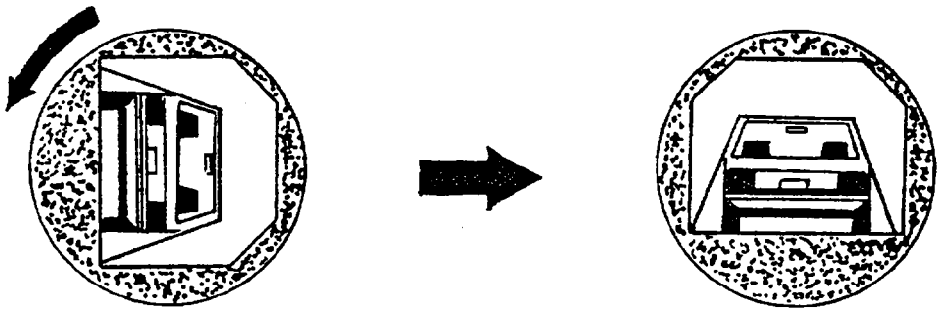
Fuel Spillage Location: Carburetor/Air Cleaner Assembly Area

TABLE X

FUEL SYSTEM INTEGRITY - FMVSS 301-75

STATIC ROLLOVER

Vehicle 1981 Mazda GLC NHTSA No. 810504



	Actual	Max. Allowed
Rollover fixture 90° rotation time	2 min. 13 sec.	1 to 3 Minutes
Fuel spillage during 5 minute period from onset of rotation	- 0 -	5 ounces
Fuel spillage during 6th minute period from onset of rotation	- 0 -	1 ounce
Fuel spillage during 7th minute period from onset of rotation	- 0 -	1 ounce

Fuel Spillage Location: Not Applicable

SECTION 3

3.1 TEST RESULTS AND PHOTOGRAPHS

Post-impact inspection of the test vehicle revealed almost all crush occurred rearward of the front doors. The left and right frame rails buckled over the rear suspension and both rear wheels were jammed. The roof buckled over both left and right "B" post and the rear window shattered. Both front seat backs bent backward unto the rear seat cushion. Both the driver and passenger dummy head made contact with the rear seat back cushion.

No fuel spillage was recorded following the test vehicle impact nor during the time period before the start of the rollover test. No measureable fuel spillage was recorded during the rollover test increment time periods.

The 1981 Mazda GLC Custom - 5 Door Hatchback test vehicle appears to comply with all the requirements of FMVSS 301-75.

Figure 3-1

1981 Mazda GLC Custom - 5 Door Hatchback

NHTSA 810504

Pre-Test, Left Side View


FMVSS 301
AETL
31
NHTSA
810504

Figure 3-2

1981 Mazda GLC Custom - 5 Door Hatchback

NHTSA 810504

Pre-Test, Full Rear View


AETL
31
NHTSA 810504
FMVSS 301
GLC
mazda

Figure 3-3

1981 Mazda GLC Custom - 5 Door Hatchback

NHTSA 810504

Pre-Test, Right Side View


AETL
31
NHTSA
810504

Figure 3-4

1981 Mazda GLC Custom - 5 Door Hatchback

NHTSA 810504

Post-Impact, Left Side View


AETL
31
NHTSA
810504

Figure 3-5

1981 Mazda GLC Custom - 5 Door Hatchback

NHTSA 810504

Post-Impact, Full Rear View

Figure 3-6

1981 Mazda GLC Custom - 5 Door Hatchback

NHTSA 810504

Post-Impact, Right Side View


AETL
31
NHTSA
810504

Figure 3-7

1981 Mazda GLC Custom - 5 Door Hatchback

NHTSA 810504

Post-Impact, Rollover Test, 90° Increment

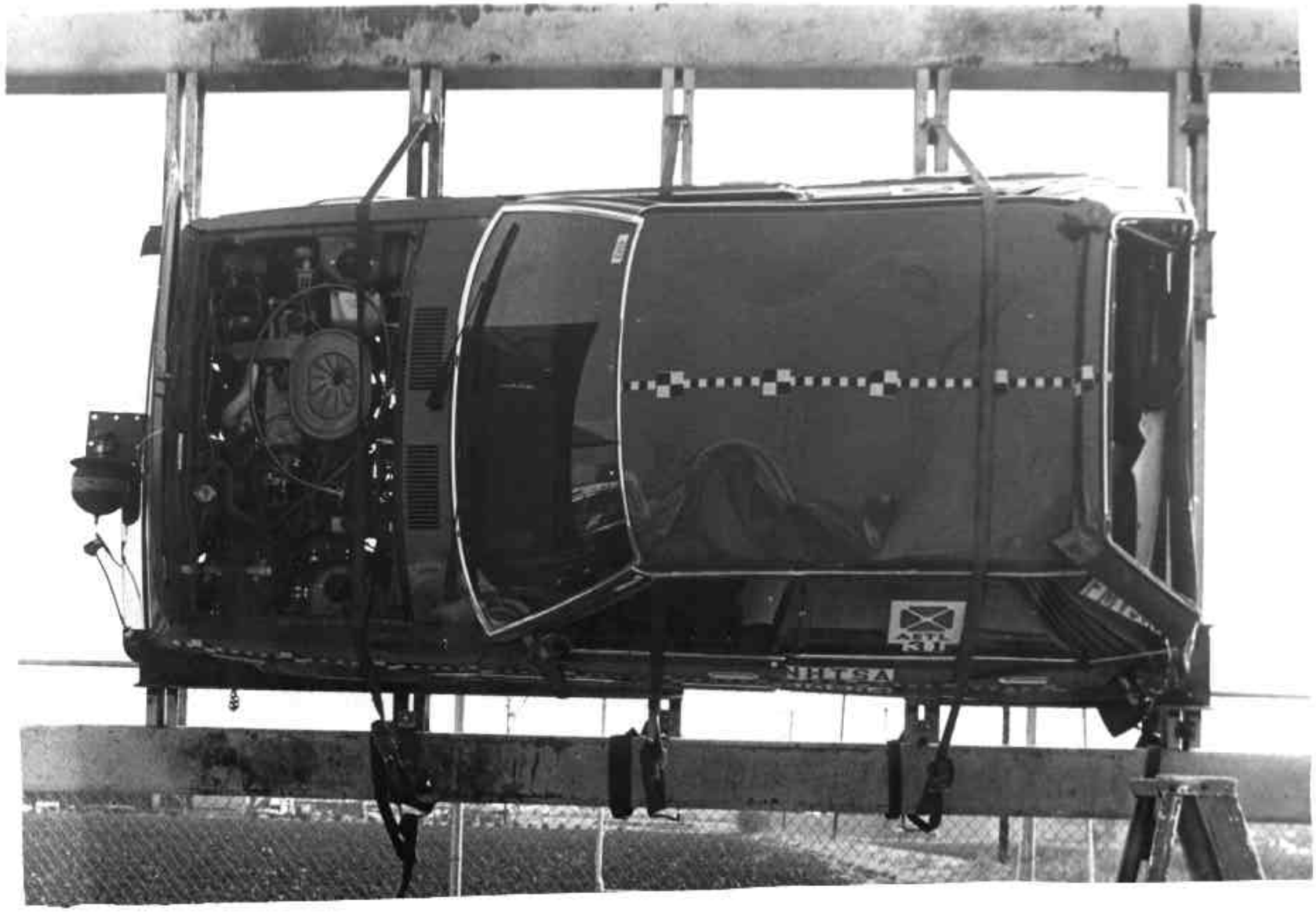
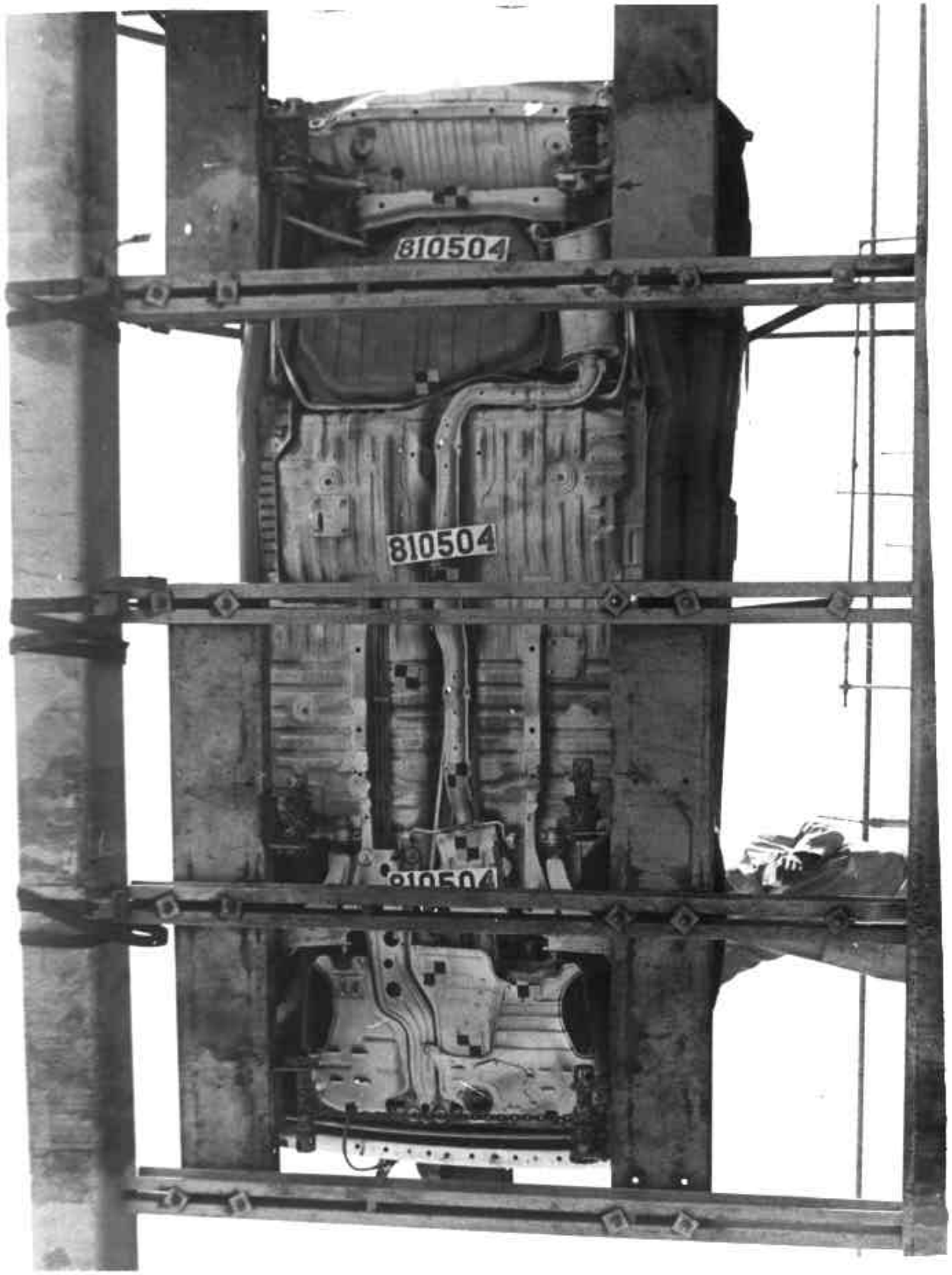


Figure 3-8

1981 Mazda GLC Custom - 5 Door Hatchback

NHTSA 810504

Post-Impact, Rollover Test, 270° Increment


810504
810504

SECTION 4

SECTION 4

4.0 OCCUPANT RESPONSE AND VEHICLE ACCELERATION SUMMARY DATA

The following data sheets summarize:

A. The dummy position data (Part 572 Dummy Pre-Test Dummy Clearance Distances Sheet)

B. The vehicle acceleration data (Vehicle Structural Data Sheet)

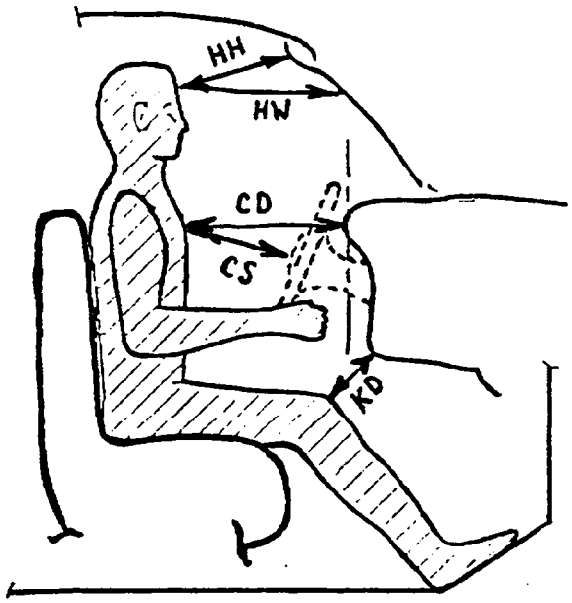
C. The pre and post-test vehicle dimensions data (Vehicle Measurement Data Sheet)

More comprehensive data is presented in Appendix B in the form of computer plots.

TABLE 4-1

PART 572 DUMMY PRE-TEST CLEARANCE DISTANCES

DRIVER		PASSENGER	
HH =	12.0 in.	HH =	15.5 in.
HW =	16.0 in.	HW =	20.0 in.
HR =	7.5 in.	HR =	6.0 in.
HS =	9.5 in.	HS =	6.5 in.
CD =	20.0 in.	CD =	21.5 in.
CS =	13.0 in.	AD =	3.5 in.
AD =	4.5 in.	HD =	7.5 in.
HD =	7.0 in.	KD =	7.0 in.
KD =	6.5 in.		



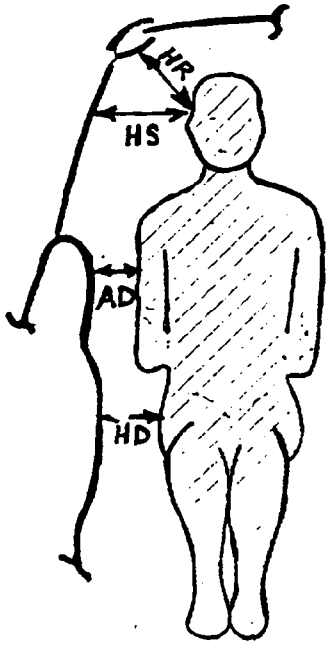


TABLE 4-2

MANUFACTURERS SEAT BELT INSTRUCTIONS

SEAT BELT RESTRAINT SYSTEM

To help protect you and your passengers from injuries in the event of an accident, your Mazda is equipped with seat lap-shoulder belts.

The front seat lap-shoulder belts are equipped with retractors which have inertia locks.

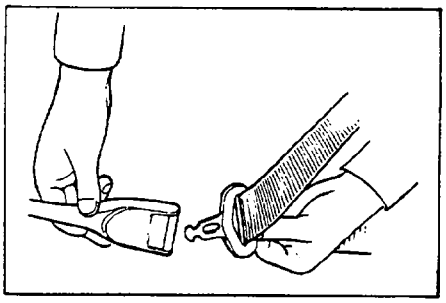
The retractors keep the belts out of the way while entering or exiting the vehicle. Inertia locks allow the belts to remain slack, for comfort, until a deceleration force occurs, such as a sudden stop or collision. At that time, the belts are automatically locked in position and the seat occupants are restrained from being thrown forward.

NOTE:

- **The retractor will lock automatically if the car is facing down aslope with to an angle greater than about 25 degrees.**
- **Before fastening the seat belts, always adjust the seat to the position in which you will drive.**

To Fasten Front Seat Belts:

1. Grasp the buckle end and tongue plate.
2. Slowly pull the lap-shoulder belt webbing out.
3. If the lap belt is not long enough to permit buckling, hold the tongue plate at right angles to the lap belt and pull the lap belt webbing through it until the desired length is obtained.
4. Insert the tongue plate into the open end of the buckle. An audible click will indicate that the belt is securely locked.

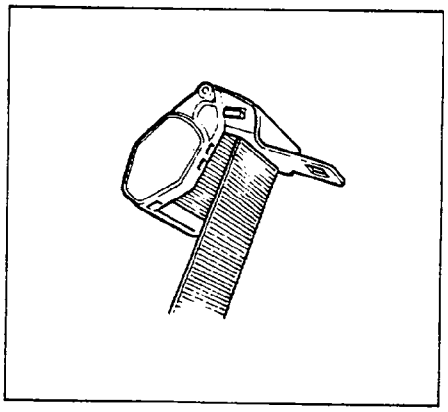


WARNING – Do not wear the shoulder belt under the arm. This practice may reduce the restraint system effectiveness.

Position the lap belt across your la as LOW ON THE HIPS as possible. T reduce the risk of sliding under th belt during an accident, adjust to SNUG FIT by pulling the belt throug the tongue plate. The belt retracto is designed to automatically take u excess webbing and maintain tensio on the belt.

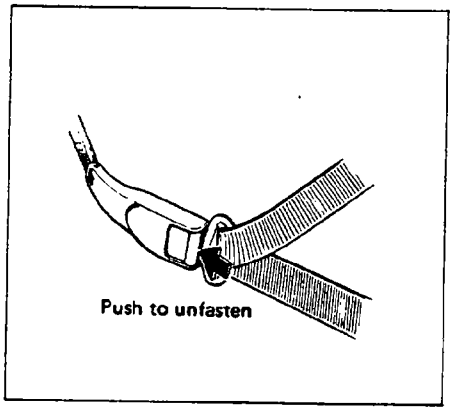
To Fasten Rear Seat Belts:

1. Grasp the buckle end.
2. Grasp the retractor and pull it until the desired length is obtained.
3. Insert the tongue plate into the open end of the buckle until an audible click is heard, which indicates the belt is locked. Make sure the belt is not twisted.



To unfasten seat belts:

Press the button on the buckle.



PROPER USE AND CARE OF SEAT BELT

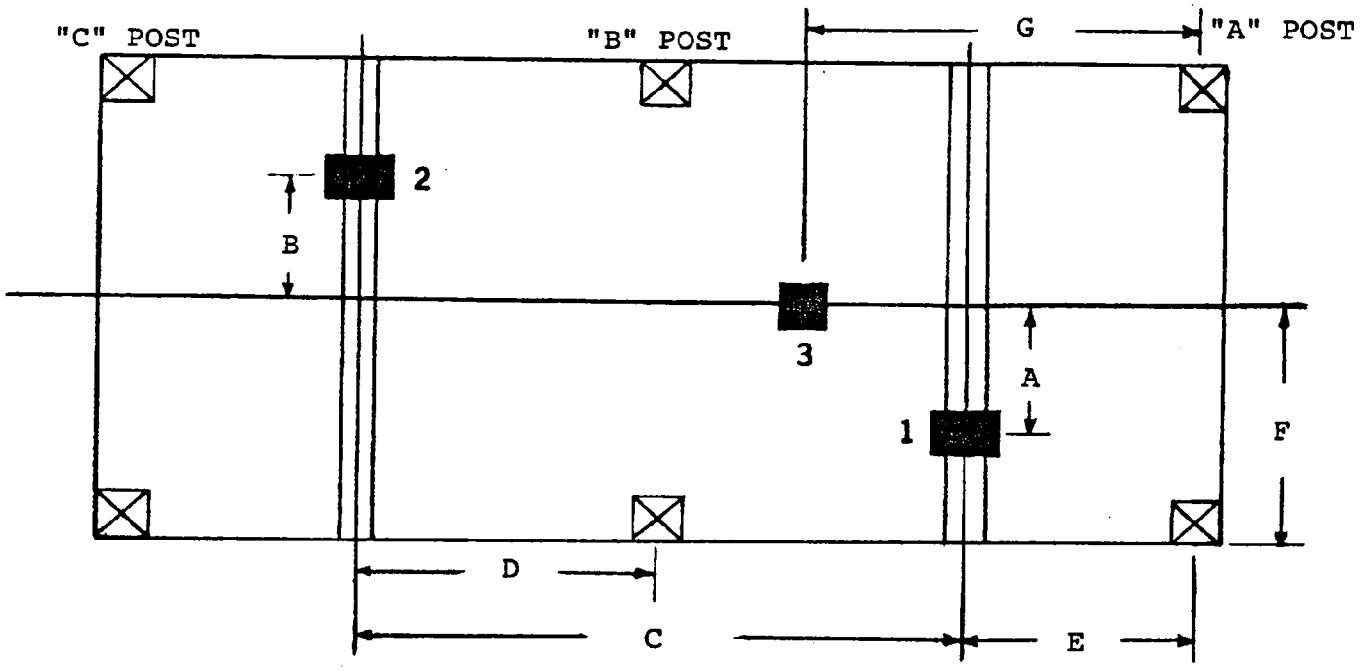
To gain maximum effectiveness from the seat belt system, please follow these suggestions –

- Use the seat belts at all times – even on short trips.
- Never use the same belt for more than one person at a time.
- The use of shoulder belts is not recommended for passengers under six years old or weighing less than 25 kg (50 pounds), as this increases the chance of neck injury in an accident.
- Avoid wearing twisted belts.
- Keep sharp edges and damaging objects away from belts, and other parts of restaint system.
- Periodically inspect belt webbing, buckles, anchors and other parts for signs of wear, damage or weakness. Replace questionable parts immediately.
- To clean the belt webbing, wash it with a mild soap or mild detergent. Do not use cleaners such as carbon tetrachloride or naphtha, etc. Beaching or dyeing is not recommended.
- No modifications or additions should be made by the user.

TABLE 4-3

VEHICLE STRUCTURAL DATA

VEHICLE 1981 Mazda GLC NHTSA NO. 801504



DIMENSIONS			
LOCATION	MEASUREMENT (IN.)	LOCATION	MEASUREMENT (IN.)
A	14.7	E	14.2
B	14.3	F	31.5
C	16.0	G	17.0
D	-4.5		

ACCELERATION PEAKS				
ACCELEROMETER LOCATION	POSITIVE* DIRECTION		NEGATIVE* DIRECTION	
	PEAK "G"	TIME (MSEC)	PEAK "G"	TIME (MSEC)
NO. 1 LONGITUDINAL	46.9	123.0	44.6	125.0
NO. 2 LONGITUDINAL	45.7	124.0	43.3	126.0
NO. 3 LONGITUDINAL	33.6	123.0	32.4	125.0

*POSITIVE - LONGITUDINAL: FORWARD DIRECTION

*NEGATIVE - LONGITUDINAL: REARWARD DIRECTION

TABLE 4-4

PRE-TEST

VEHICLE MEASUREMENT DATA

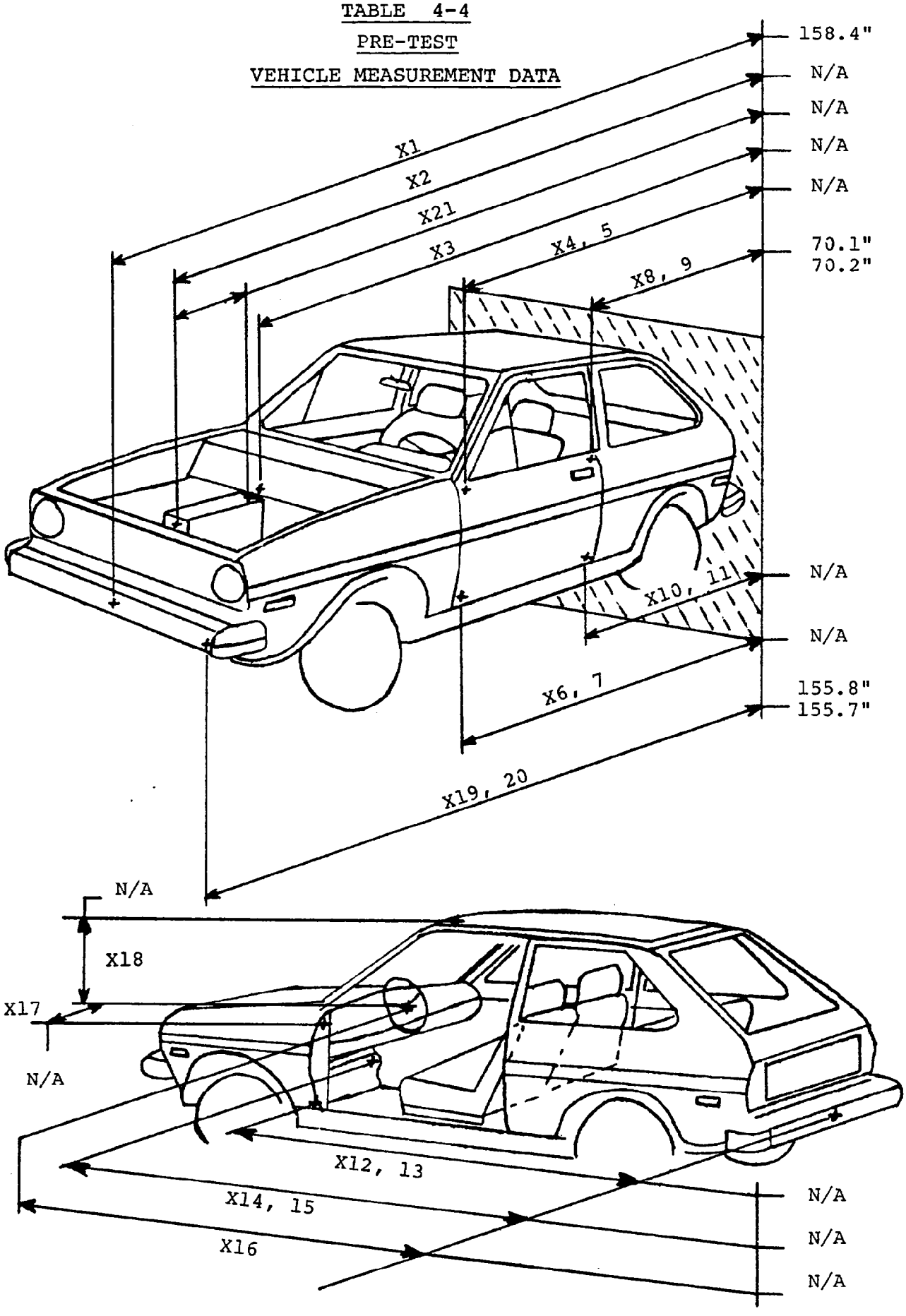


TABLE 4-5

POST-TEST

VEHICLE MEASUREMENT DATA

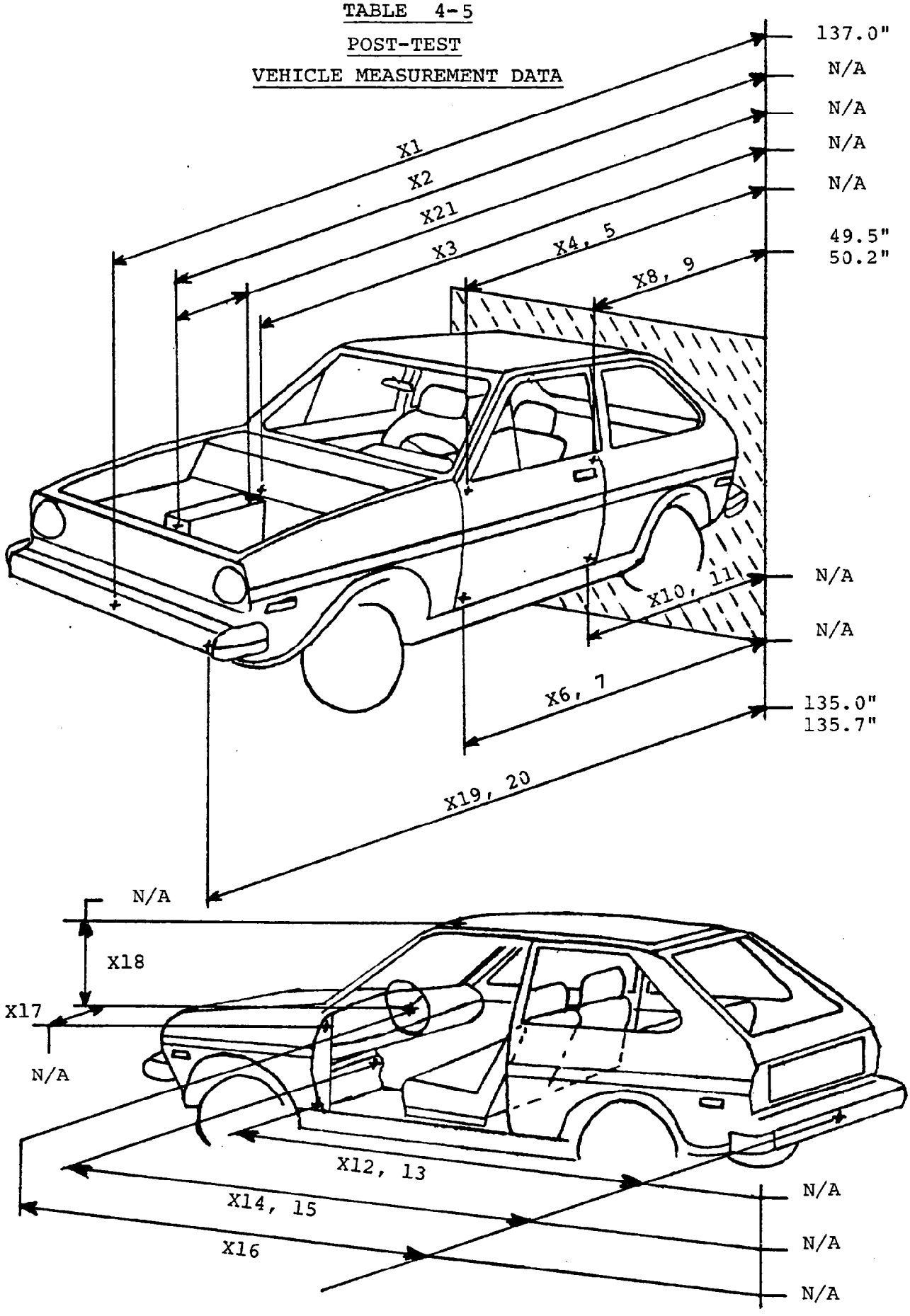


TABLE 4-6

SUMMARY

PRE-TEST AND POST-TEST VEHICLE DIMENSIONS

Measurement Point	Pre-Test	Post-Test	Difference
X1	158.4"	137.0"	21.4"
X8	70.1"	49.5"	20.6"
X9	70.2"	50.2"	20.0"
X19	155.8	135.0"	20.8"
X20	155.7	135.7"	20.0"

TABLE 4-7
FMVSS 301-75
CAMERA POSITIONS

VEHICLE 1981 Mazda GLC

NHTSA NO. 810504 TEST DATE January 14, 1981

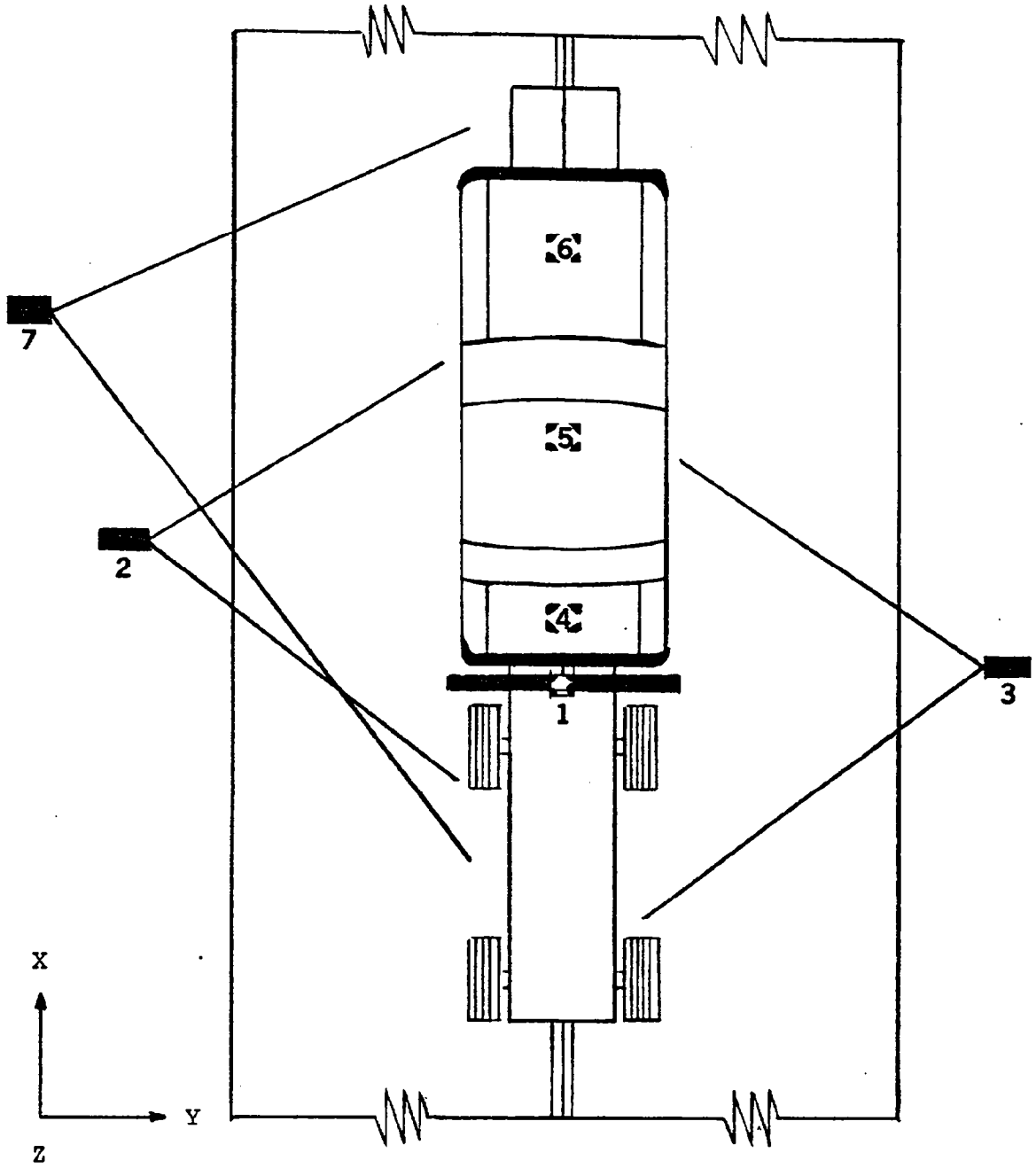


TABLE 4-8

FMVSS 301-75

CAMERA POSITIONS

VEHICLE 1981 Mazda GLC

NHTSA NO. 810504 TEST DATE Januray 14, 1981

1.	Photo-Sonics 13mm 500FPS	X 7.5" Y - 0 - Z 99.0"	2.	Locam 13mm 500FPS	X 46.5" Y 213.0" Z 46.0"
3.	Locam 13mm 500FPS	X 48.0" Y 188.0" Z 52.0"	4.	Photo-Sonics 13mm 500FPS	X -16.0" Y 1.5" Z -38.0"
5.	Photo-Sonics 13mm 500 FPS	X 44.5" Y 3.0" Z -39.0"	6.	Photo-Sonics 13mm 500FPS	X 103.0" Y 2.0" Z -41.0"

7. Canon Scoopic
   12.5 - 75mm 24FPS
   - Documentary -

SECTION 5

SECTION 5

5.0 TEST FACILITIES AND EQUIPMENT

Approved Engineering Test Laboratories (AETL) collision barriers, vehicle static rollover machine, and data processing/computer analysis test facilities are located at the Fullerton, California Division.

This section discusses these specialized facilities, along with associated equipment and instrumentation required for the performance of this test.

5.1 FRONTAL COLLISION BARRIER FACILITY

5.1.1 The frontal (fixed) collision barrier conforms to the requirements as set by the NHTSA Office of Vehicle Safety Compliance (OVSC) and as defined in the Laboratory Procedures for FMVSS 212/219/301-75, TP219-02, dated January 9, 1979, with the following special characteristics.

5.1.2 The fixed collision barrier is a steel clad, steel reinforced concrete block with a 6'4" X 12' face. The face is 1" steel plate faced with 3/4 inch plywood. The total mass of the structure is approximately 200,000 pounds, with a substantial portion below ground to provide resistance against sliding or tipping of the barrier during impact.

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5.1.3 The facility consists of a 500 foot concrete paved runway, with a steel monorail embedded in the approach surface. Two camera pits are provided to allow photographing the test vehicle at impact. One pit is located immediately in front of the fixed collision barrier and is 36 inches wide (expandable to 48 inches), 7 feet deep, and 23 feet long (3 feet of the pit length extends under the barrier face). The second (mid) pit with removable monorail section is located approximately 160 feet from the fixed collision barrier and is 43 inches wide, 7 feet deep, and 23 feet long.

5.1.4 Tow propulsion is provided by a fixed prime mover and continuous cable drive system located near the mid camera pit position. The power plant for the tow cable system is a 200 h.p. synchrouous electric motor, coupled to an electronically controlled Eddy Current Clutch and a 4:1 gear reduction transfer assembly.

The endless 1/2 inch diameter steel tow cable is wrapped around the drive pulley and is tensioned by a pneumatic loaded idler wheel. The tow cable passes through the fixed collision barrier and around fixed idler pulleys to complete the loop. The test vehicle or moving collision barrier is towed by a dolly assembly attached to the vehicle

or moving collision barrier by a shear pin release mechanism. For a fixed collision barrier test, the test vehicle is towed within 20 feet of the fixed barrier, at which point the towing dolly assembly is disconnected from the test vehicle and the test vehicle proceeds under its own momentum for the final 20 feet to impact. For a moving collision barrier test, the moving collision barrier is towed within 5 feet of the test vehicle, at which point the towing dolly is disconnected from the moving collision barrier and the moving collision barrier proceeds under its own momentum for the final 5 feet to impact. Heavy steel stops actuate the tow cable release mechanism and prevent the towing dolly from continuing past the point of impact. The towing dolly is designed to fit inside the monorail such that it is constrained in the vertical and lateral directions, and capable of sliding freely along the monorail.

5.2 OBLIQUE ANGLE COLLISION BARRIER

5.2.1 The oblique angle collision barrier conforms to the requirements as set by NHTSA Office of Vehicle Safety Compliance (OVSC) Laboratory Procedures TP219-02, with the following special characteristics.

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5.2.2 The oblique angle collision barrier is constructed of a flat 1 1/2 inch steel plate faced with 3/4 inch plywood. The barrier face is 6' X 12' and is adjustable for left or right angle impacts by means of seven tubular gussets that attach to the standard fixed frontal collision barrier to form a rigid buttress structure.

5.3 MOVING COLLISION BARRIER

5.3.1 The moving collision barrier conforms to the requirements as set by Federal Motor Vehicle Safety Standard No. 208, Paragraph S8.2 with the following special characteristics.

5.3.2 The chassis is constructed of 12 inch steel channel with tubular frame gussets. The flat impacting face plate is 1/2 inch steel plate faced with 3/4 inch plywood. The face plate is reinforced with 6 inch steel channel horizontally welded to the chassis to form a rigid symetrical structure. A camera boom extends above the barrier face plane to provide a view of barrier to vehicle impact. The barrier assembly weighs 3,977 pounds and has a four wheel electric brake system.

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5.4 VEHICLE STATIC ROLLOVER MACHINE

5.4.1 The vehicle static rollover machine conforms to the requirements as set by the NHTSA Office of Vehicle Safety Compliance (OVSC) Laboratory Procedures TP219-02 with the following special characteristics.

5.4.2 The vehicle static rollover machine is constructed of 10 inch square tube with adjustable wheelbase and tread width platforms to accommodate the various test vehicles. The total usable platform area is 8 feet wide and 25 feet long with special design feature to accomodate vehicles with a gross vehicle weight rating (GVWR) of 10,000 pounds or less with various body configuration heights to 12 feet. The test vehicle can be rotated left or right and can turn each 90° rotational increment in approximately two (2) minutes.

5.5 IMPACT VELOCITY MEASUREMENT

The test vehicle impact velocity is measured by two (2) separate certification timing trap systems located within five (5) feet of the vehicle to fixed collision barrier face and to one side on the approach apron. Each timing

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trap system contains two (2) optical beams, mounted twenty four (24) inches apart, in a mechanical housing assembly providing a start-stop signal to a digital display counter. As the test vehicle traverses the impact apron, a blade attached to the test vehicle rear fender interrupts each optical beam providing the precise measurement of time interval for the test vehicle to advance the known distance between the optical beams. Each interval of time measurement is stored in the digital display counter and photographically recorded.

The moving collision barrier impact velocity is measured by two (2) separate certification timing trap systems located within five (5) feet of the moving collision barrier to vehicle impact location and to one side on the approach apron. Each timing trap system contains two (2) optical beams, mounted twenty-four (24) inches apart, in a mechanical housing assembly providing a start-stop signal to a digital display counter. As the moving barrier traverses the impact apron, a blade attached to the moving barrier side interrupts each optical beam providing the precise measurement of time interval for the moving barrier to advance the known distance between the optical beams. Each interval of time measurement is stored in the digital display counter and photographically recorded.

SECTION 5

5.6 PHOTOGRAPH COVERAGE

5.6.1 Because FMVSS 212/219/301-75 may be a combined test, it is necessary that all photographic coverage of the test vehicle be done at one time with specific photographs to document the areas for Vehicle Safety Compliance consideration; windshield area and the fuel system. Each report will utilize only those photographs pertaining to the Vehicle Safety Compliance Test being reported.

5.6.2 FIXED BARRIER IMPACT TEST

Motion picture coverage of the event employs seven (7) 16mm 1B Photo-Sonics cameras and four (4) 16mm 51 Redlake Locam cameras using color film at 500 frames per second (fps). Also a 16mm Canon Scoopic 24 frames per second (fps) camera with color film is used to record vehicle pre-test condition, vehicle in-run, impact, and post-impact vehicle conditions including the rollover increments for documentary purposes. The eleven (11) high speed cameras are located at stationary positions near the point of impact. One is an overhead camera mounted on a tower above the fixed barrier face on centerline of the test vehicle at impact. Its field of view includes the barrier face and the front of the vehicle to a point about one foot aft of the windshield. A second and third camera are mounted on top of the fixed barrier with

their field of view concentrating on the windshield area (FMVSS 212/219). The fourth and fifth cameras each have a side view of the test vehicle at impact. The sixth, seventh, eight, and ninth cameras are located adjacent to the test vehicle front passengers compartment and positioned to photograph motion of each test dummy at impact. The tenth and eleventh cameras are located in the pit and positioned to photograph the underside of the engine compartment and fuel tank area.

5.6.3 MOVING BARRIER IMPACT TEST

Motion picture coverage of the event employs four (4) 16mm 1B Photo Sonics cameras and two (2) 16mm 51 Redlake Locam cameras using color film at 500 frames per second (fps). Also a 16mm Canon Scoopic 24 frames per second (fps) camera with color film is used to record vehicle pre-test condition, barrier in-run, impact, and post-impact vehicle conditions including the rollover increments for documentary purposes. Five (5) of the high speed cameras are located at stationary positions near the point of impact. Three (3) cameras are located in the pit and positioned to photograph the underside of the engine compartment, with overlapping field of views, aft to the fuel tank area. The fourth and fifth cameras each have a side view of the test vehicle at impact.

The sixth camera is attached to the moving collision barrier to photograph the contact between the barrier and the test vehicle.

5.6.4 TIME PULSE GENERATOR

Time data from two (2) sources are contained in the high speed film coverage. The first is a time reference of 100 pulse per second (pps) light emitting diode event mark along the film adge. This pulse is generated by the time pulse generator and fed to all high speed cameras. Thus, it is possible to relate film data to a real time base. The second time record is an indication of time zero (moment of impact). This is accomplished by a trip switch and event mark system. The trip switch is positioned at the impact point so that it triggers the light emitting diode event mark along the film edge at the moment of bumper-barrier contact. Thus, the particular film frame corresponding to the point of impact is clearly indicated on all the high speed film.

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5.7 DATA ACQUISITION AND REDUCTION

The data acquisition and analysis system used for acquiring occupant response and vehicle acceleration are shown schematically in Figure 5-1. A complete list of instrumentation is provided in Table 5-1. An itemized procedure for acquiring data is provided on Table 5-2.

Prior to the vehicle impact test the onboard instrumentation package is installed and a calibration and null reference check is performed to checkout all data analog devices including the FM magnetic tape recorders. The moment of impact trigger switch attached to the vehicle is also checked out. Immediately following vehicle impact a post-impact calibration and null reference check is performed.

The analog data is then played back into a Hewlett Packard Digital Fourier Analyzer (DFA) system using a HP 2100S mini computer with 32K word core storage. This system uses four program controlled analog filters which provides pre-digitizing filter capability of 48 db/octave above 1250 Hz.

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The DFA is a hard disc based system with standard HP design software for performing data acquisition and analysis functions. The HP software is programmed using direct keyboard functions to automate the data reduction process. The data is entered into temporary storage, four channels (one set) at a time. Table 5-3 defines each data channel and data set. The data sets are divided into driver and passenger tape recorder groups to facilitate simultaneous data acquisition for the head, chest and vehicle accelerometers to assure appropriate calibration of injury criteria and vehicle dynamics. At the time of entry, test personnel enter the appropriate calibration for each data channel and the computer then scales the data appropriately. When all data has been acquired it is moved as a vehicle set to permanent storage on a removable magnetic disc. (Nine vehicle sets are stored on each magnetic disc. All magnetic discs and FM recorder tapes are retained on file at AETL).

The only modifications to the data at the time of permanent storage is the filtering and digitizing process of the FM tape recorder (2500 Hz) and the DFA (1250 Hz sampling for a 500 ms window). After the data is moved to permanent storage it is recalled by test personnel and plotted with the appro-

priate label and vehicle designation. As the data is recalled, the DFA is programmed to automatically filter the data with the appropriate SAE filter.

Figure 5-2 illustrates the SAE class 60, 180, 600 and 1000 filters applied to the data. These filters are in accordance with SAE J211a, Instrumentation for Impact Tests. These recommended filters are quadratic double pole with 65% damping and a 12 db/octave rolloff. They are applied to the data using a Fast Fourier Transform (FFT) of the data, frequency domain multiplication, and an inverse Fast Fourier Transform (FFT) of the product.

It should be noted that in Figure 5-2 the predigitizing analog filter attenuates all signals above the 1250 Hz cutoff frequency. This has no effect on the class 60 or class 180 data. The class 600 data is within SAE J211a recommendation to 1900 Hz and -20 db. Above 1900 Hz the class 600 data is attenuated at 48 db/octave instead of 24 db/octave. This has very negligible effect on the class 600 data. The modification of class 1000 data, by predigitizing filter, is attenuation of 48 db/octave above

1250 Hz instead of 24 db/octave above 1650 Hz. Examination of typical class 1000 data shows the high frequency components between 1250 Hz and 1650 Hz are uniformily less than 3 percent of the largest components at lower frequencies. The effect of the predigitizing filter has a very slight smoothing of the plotted data.

Class 60 filters are applied to the vehicle acceleration and belt restraint forces, while the class 180 filter is applied to the chest acceleration forces. The class 600 filter is applied to the femur forces and class 1000 filter is applied to the head acceleration forces.

5.7.1 IMPACT DATA

All impact data is presented in computer plots of data digitized at 500 microseconds. Special SAE filters are applied to the appropriate data sets. Each data plot includes labeling, defining the test vehicle, filter class, and the complete identification of the data plotted.

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5.7.1.2 DUMMY HEAD DATA

The dummy head accelerations are processed as class 1000 data, and the Head Injury Criteria (HIC) calculation is performed. The HIC calculations are maximized for start time (T1) and end time (T2), using a manual iteration routine, usually requiring about ten interations and between 5,000 and 10,000 combinations of start and end times. Data output is in the form of computer plots with the final HIC calculations. Listing of data value and HIC calculations are available, but not provided in the final report.

5.7.1.3 DUMMY CHEST DATA

The dummy chest accelerations are processed as class 180 data, and direct Chest Severity Index (CSI) calculations and the highest acceleration value of at least three millisecond duration (3 ms clip) are performed. Data output is in the form of computer plots with the 3 ms clip calculations.

5.7.1.4 FEMUR LOAD DATA

The dummy femur loads are processed as class 600 data, and presented as computer plots.

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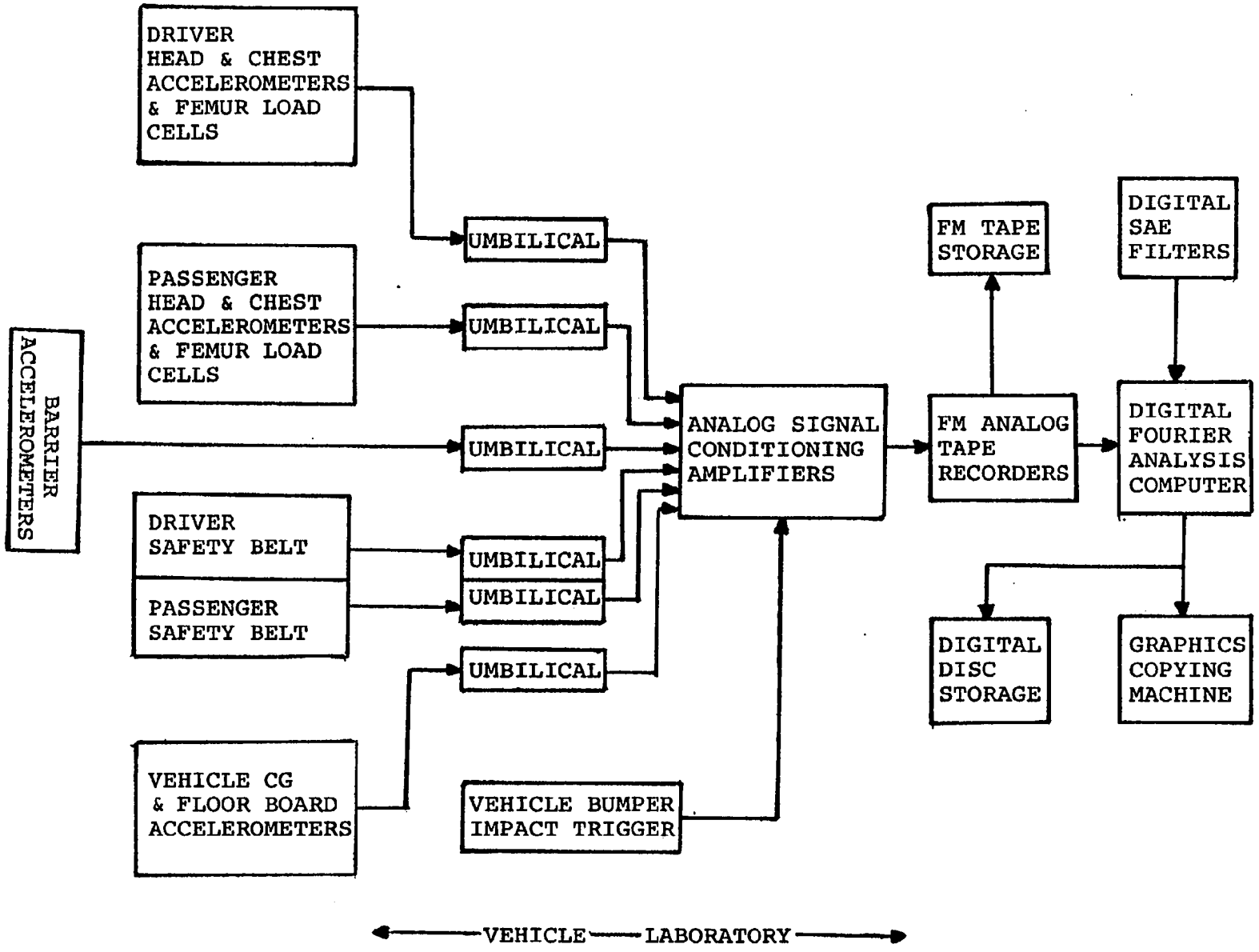
5.7.1.5 RESTRAINT LOAD DATA

The dummy restraint loads are processed as class 60 data, and presented as computer plots.

5.7.1.6 VEHICLE ACCELERATION DATA

The vehicle accelerations are processed as class 60 data, and presented as computer plots. Additionally, the longitudinal vehicle acceleration is integrated to provide approximate vehicle velocity change and vehicle crush during the impact event.



VEHICLE AND OCCUPANT CRASH IMPACT DATA ACQUISITION SYSTEM

FIGURE 5-1

TABLE 5-1 INSTRUMENTATION FOR CRASH TEST

Instrument	Manufacturer	Model No.	Full Scale	Accuracy	Frequency Max.
Accelerometers, Head, Chest, Vehicle	Endevco	2262C-200	200g	±1%	3600 Hz
Load Cells, Femurs	GSE	2430	3000 lb	±1%	>3600 Hz
Load Cells, Safety Belts	GSE	2500	3000 lb	±1%	>3600 Hz
Contact Switch, Impact	AETL	-	2 V	-	<200 us rise time
FM Tape Recorder	Bell & Howell	4020	±2.8 V	47 db SNR	2500 Hz WB
Programmable Filter, All Data	Hewlett Packard	54440A	-	0.5%	1250 Hz, 48 db/oct
Analog-Digital Converter, All Data	Hewlett Packard	5466B	-	0.5%	200 us sampling
Analysis Computer, All Analysis	Hewlett Packard	2100S	32 K Words	16 Bit Word	-
Disc Drive	Hewlett Packard	7900A	5 Meg Words	-	-

TABLE 5-2

DATA ACQUISITION AND REDUCTION PROCESS

STEP	DESCRIPTION
1	DA System Installation
2	DA System Pre-Impact Calibration
3	Impact Trigger Checkout
4	Vehicle Impact Performed
5	DA System Post-Impact Calibration
6	Data Reproduced From FM Tape Into Computer a) Data analog filtered at 1250 Hz b) Data digitized at 500 ms sample rate c) Data sychronized by impact trigger signal
7	Digitized Data Examined
8	Data Transfered Permanent Disc Storage
9	Appropriate SAE Filters Are Applied
10	Each Data Signal Plotted With Lables
11	Chest Severity Index Values Determined
12	Head Injury Criteria Values Determined
13	Vehicle Dynamics Evaluated (MPH & Crush)

TABLE 5-3

DATA DESIGNATIONS FOR VEHICLE CRASH IMPACT DATA ACQUISITION

DATA SET	TAPE NO.	CHANNEL NO.	DESCRIPTION
1	1	1	Vehicle Longitudinal CG Acceleration Ax
1	1	2	Right Front Floor Pan Longitudinal Acceleration Ax
1	1	3	Left Rear Floor Pan Longitudinal Acceleration Ax
1	1	4	Barrier Longitudinal CG Acceleration Ax

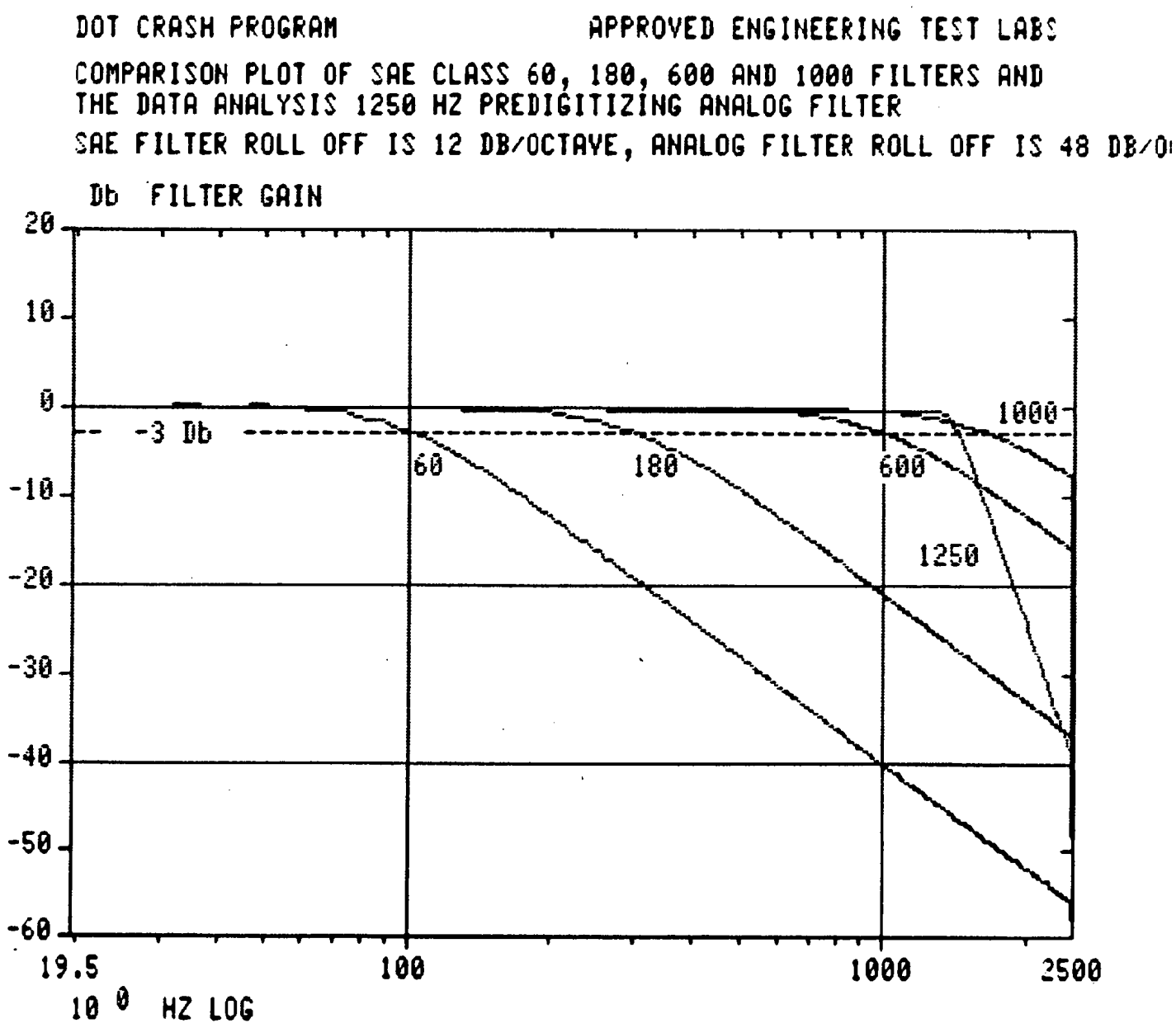

DOT CRASH PROGRAM
APPROVED ENGINEERING TEST LABS
COMPARISON PLOT OF SAE CLASS 60, 180, 600 AND 1000 FILTERS AND
THE DATA ANALYSIS 1250 HZ PREDIGITIZING ANALOG FILTER
SAE FILTER ROLL OFF IS 12 DB/OCTAVE, ANALOG FILTER ROLL OFF IS 48 DB/O
Db FILTER GAIN
20
10
0
-10
-20
-30
-40
-50
-60
-3 Db
60
180
600
1000
1250
19.5
100
1000
2500
10 0 HZ LOG

FIGURE 5-2

APPENDIX A

APPENDIX A

The following photographs are pre and post test dummy positions and interior compartment locations of dummy contact during the impact event.

Figure A-1

1981 Mazda GLC Custom - 5 Door Hatchback

NHTSA 810504

Pre-Test, Driver Dummy View


810504

Figure A-2

1981 Mazda GLC Custom - 5 Door Hatchback

NHTSA 810504

Pre-Test, Passenger Dummy View


810504

Figure A-3

1981 Mazda GLC Custom - 5 Door Hatchback

NHTSA 810504

Post-Impact, Driver Dummy View


810504

Figure A-4

1981 Mazda GLC Custom - 5 Door Hatchback

NHTSA 810504

Post-Impact, Driver Dummy View

Figure A-5

1981 Mazda GLC Custom - 5 Door Hatchback

NHTSA 810504

Post-Impact, Dummy Contact Area

Figure A-6

1981 Mazda GLC Custom - 5 Door Hatchback

NHTSA 810504

Post-Impact, Dummy View

Figure A-7

1981 Mazda GLC Custom - 5 Door Hatchback

NHTSA 810504

Post-Impact, Passenger Dummy View

Figure A-8

1981 Mazda GLC Custom - 5 Door Hatchback

NHTSA 810504

Post-Impact, Passenger Dummy View

Figure A-9

1981 Mazda GLC Custom - 5 Door Hatchback

NHTSA 810504

Post-Impact, Passenger Dummy Contact Area

Figure A-10

1981 Mazda GLC Custom - 5 Door Hatchback

NHTSA 810504

Post-Impact, Passenger Dummy Contact Area

APPENDIX B

APPENDIX B

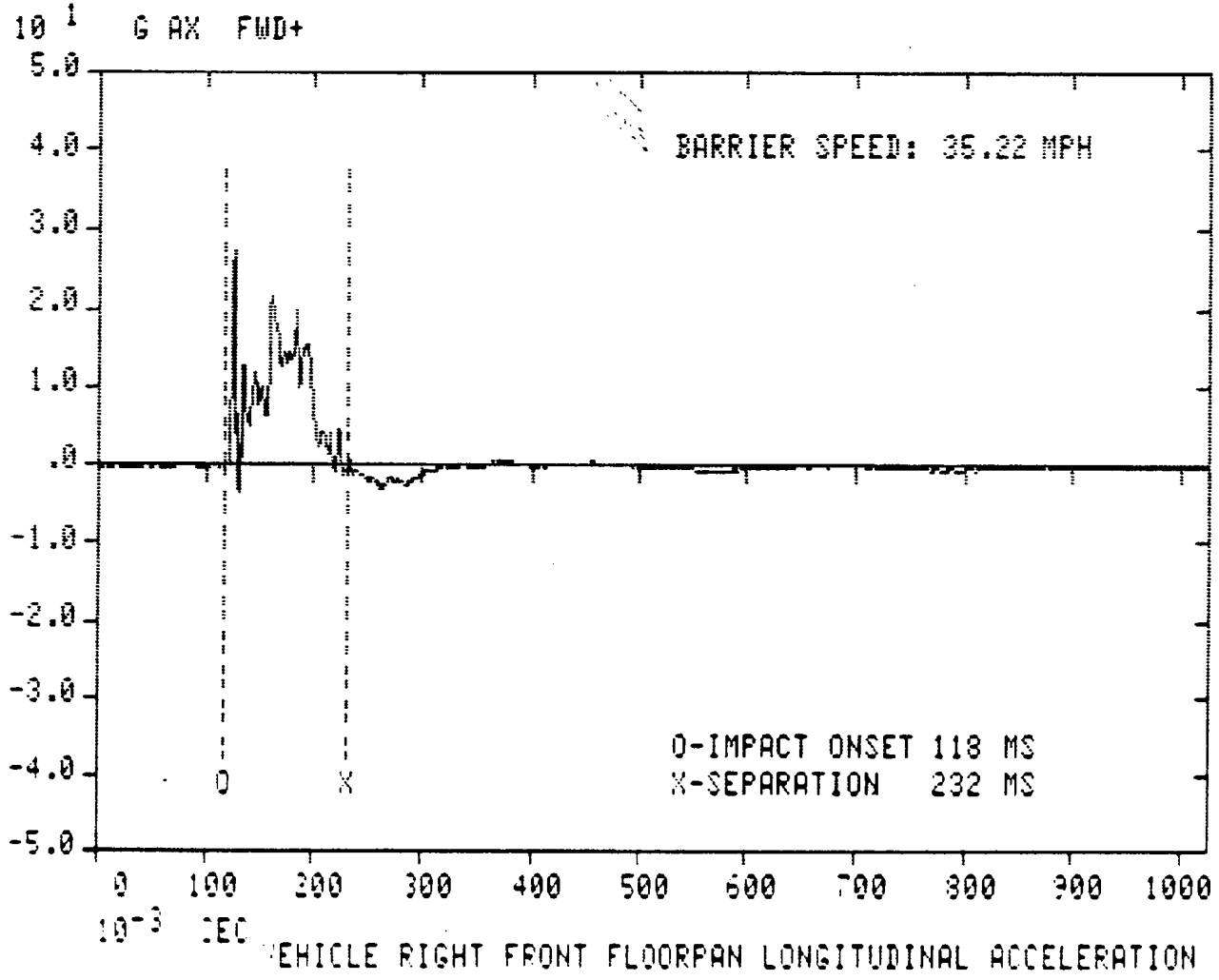
The following computer plots provide complete and comprehensive vehicle acceleration during the rear moving barrier impact test of a 1981 Mazda GLC Custom - 5 Door Hatchback, NHTSA 810504.

DOT CRACH PROGRAM

APPROVED ENGINEERING TEST LABS

VEHICLE: MAZDA GLC
VEHICLE ID: NHTSA 810504
TEST FILE NO: 45 REAR IMPACT
DATE: JANUARY 14, 1981

MJO NO: 971-3882-31
FILTER: CLASS 60



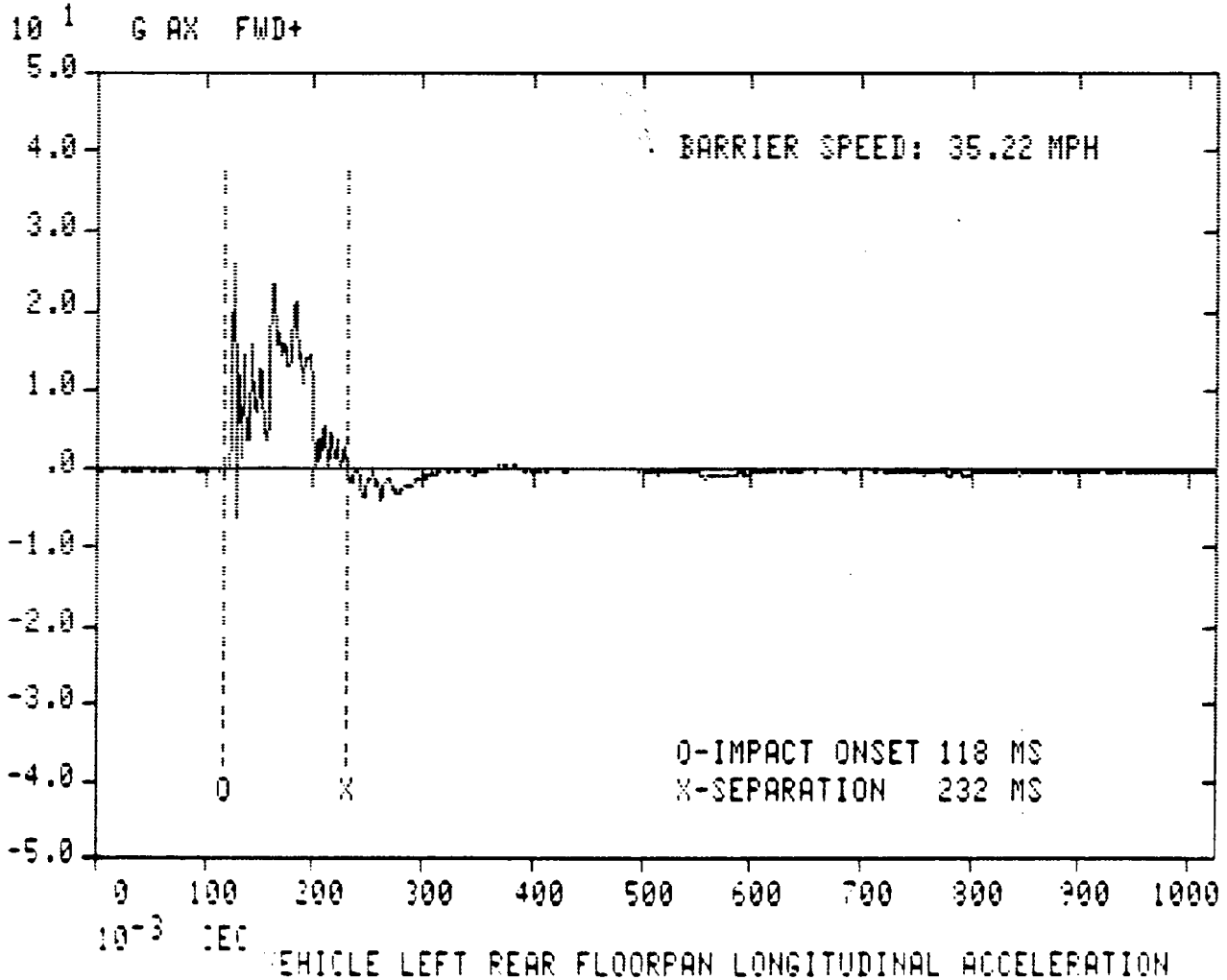
VEHICLE RIGHT FRONT FLOORPAN LONGITUDINAL ACCELERATION

DOT CRASH PROGRAM

VEHICLE: MAZDA GLC
VEHICLE ID: NHTSA 810504
TEST FILE NO: 45 REAR IMPACT
DATE: JANUARY 14, 1981

APPROVED ENGINEERING TEST LABS

MJO NO: 971-3882-31
FILTER: CLASS 60



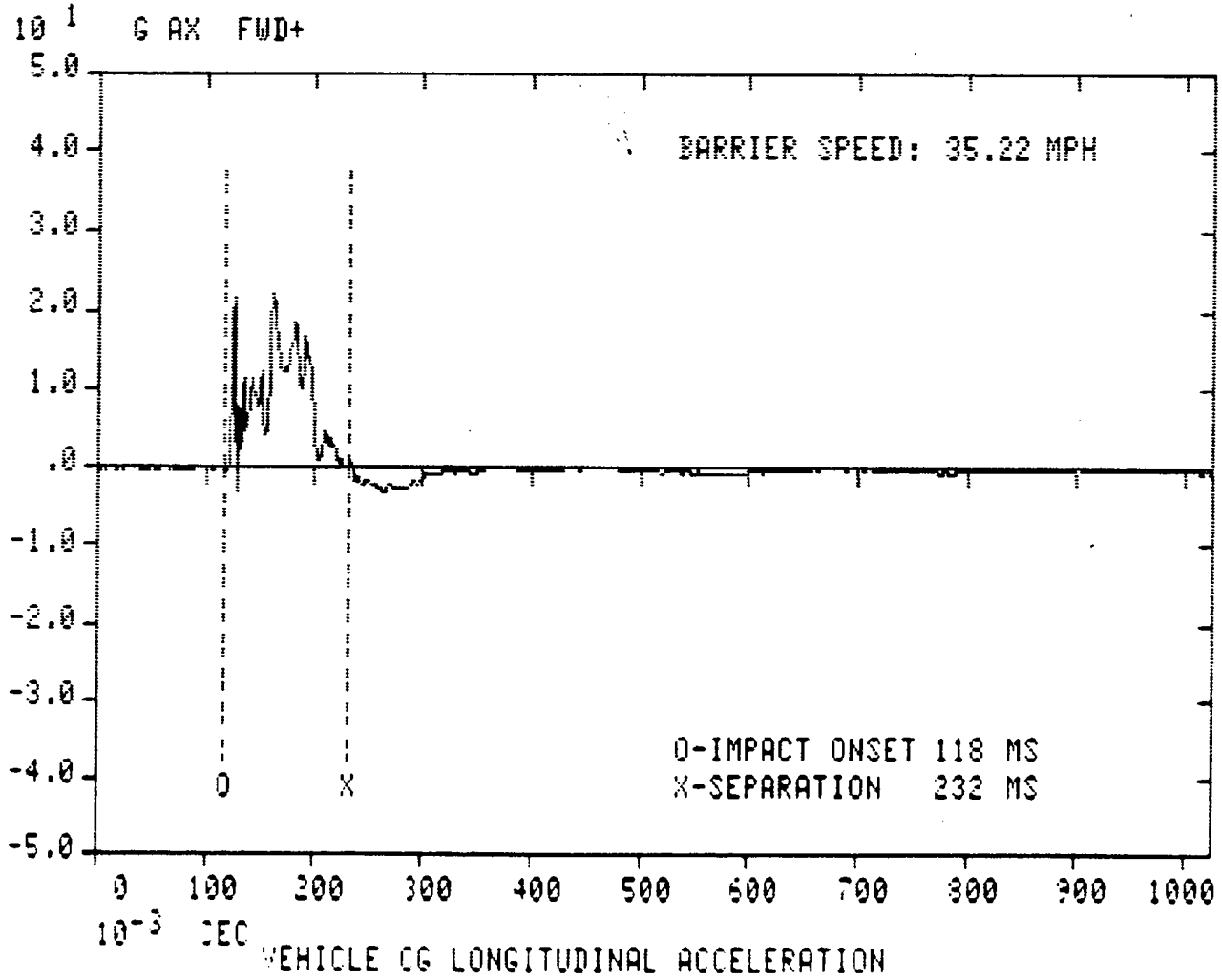
VEHICLE LEFT REAR FLOORPAN LONGITUDINAL ACCELERATION

DOT CRASH PROGRAM

APPROVED ENGINEERING TEST LABS

VEHICLE: MAZDA GLC
VEHICLE ID: NHTSA 810504
TEST FILE NO: 45 REAR IMPACT
DATE: JANUARY 14, 1981

MJO NO: 971-3882-31
FILTER: CLASS 60



VEHICLE CG LONGITUDINAL ACCELERATION

APPROVED ENGINEERING TEST LABORATORIES

SERVICE FOR: U. S. Department of Transportation
National Highway Traffic Safety Administration
Enforcement
Office of Vehicle Safety Compliance
400 Seventh Street S. W.
Washington, D. C. 20590

CONTRACT NUMBER: DOT-HS-9-02273

I hereby certify that the preceding report is true and correct to the best of my knowledge.

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