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Report Numbers: TRC-95-V006

Rear Impact Full-Scale Crash Testing for Upgrade of FMVSS 301 Test Procedure

Deformable Impactor into Rear of
1996 Plymouth Voyager
at 80 kph with 70% Overlap
TRC Test Number: 960322

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April 19, 1996
Final Report

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2443

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16. Abstract

An 80 kph deformable impactor rear crash test with 70% overlap was conducted on a 1996 Plymouth Voyager minivan at Transportation Research Center Inc. on March 22, 1996. This test was conducted to determine vehicle and occupant response in the rear 70% overlap test mode. The impactor's velocity was 81.5 kph. The impactor's weight was 1342 kg. The vehicle's maximum crush was 435 millimeters. The ambient temperature was -3° C.

The driver's Head Injury Criteria (HIC) was 690. The driver's chest maximum resultant acceleration with three (3) milliseconds minimum duration was 15.8 g. The driver's chest maximum deflection was 2 mm. The driver's left and right femur maximum axial forces were 1945 N and 1129 N, respectively.

The passenger's HIC was 1578. The passenger's chest maximum resultant acceleration with three (3) milliseconds minimum duration was 15.5 g. The passenger's chest maximum deflection was 3 mm. The passenger's left and right femur maximum axial forces were 2067 N and 2032 N, respectively.

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Purpose

This crash test was conducted to determine vehicle and occupant response in the 80 kph rear impact with 70% overlap test mode. The test was performed on a 1996 Plymouth Voyager minivan.

Test Procedure

This test was conducted per Contract No. DTRS57-95-C-00011, Technical Task Directive No. 1, "Rear Impact Full-Scale Crash Testing for Upgrade of FMVSS 301 Test Procedure."

The test vehicle was instrumented with nine (9) accelerometers to measure longitudinal axis accelerations.

The test vehicle contained two (2) Part 572 E 50th percentile adult male anthropomorphic test devices (dummies). The dummies were positioned in the front outboard designated seating positions according to the dummy placement procedure specified in Appendix C of the Laboratory Test Procedure TP-208-09.

The deformable impactor was instrumented with five (5) force load cells to measure longitudinal axis forces on the barrier face.

The impactor's specified velocity range was 80.1 to 81.8 kph.

Both dummies were instrumented with head center of gravity and Position 1, 2, and 3 accelerometers to measure longitudinal, lateral, and vertical accelerations; neck upper and lower 6-axis load cells to measure longitudinal, lateral, and vertical force and moments; chest and pelvis accelerometers to measure longitudinal, lateral, and vertical axis accelerations; and with left and right femur load cells to measure axial forces. Each Part 572 E dummy's instrumentation also included a chest potentiometer to measure longitudinal deflection. Additionally, the driver dummy was instrumented with shoulder and lap belt load cells.

The seventy-six (76) data channels were digitally sampled at 12,500 samples per second and processed per Sections 11.13 through 11.15 of the Laboratory Test Procedure.

The crash event was recorded by thirteen (13) high-speed motion picture cameras.

The vehicle and occupant data are summarized in Section 2.0. The FMVSS 301 data are presented in Section 3.0. The vehicle, occupant, and camera measurements are presented in Section 4.0. Appendix A contains the still photographic prints. Appendix B contains the dummy and vehicle data plots. Appendix C contains the dummy calibration information. Appendix D contains miscellaneous test information

Test Results Summary

This 80 kph rear crash test with 70% overlap was conducted at TRC on March 22, 1996.

No fluid spilled from the vehicle's fuel system following the impact.

The test vehicle, a 1996 Plymouth Voyager minivan, was equipped with airbags and three-point unibelts at the driver's and right front passenger's seating positions. The vehicle's test weight was 1946 kg. The vehicle's maximum static crush was 435 mm.

The driver's HIC was 690. The driver's chest maximum resultant acceleration with three (3) milliseconds minimum duration was 15.8 g. The driver's chest maximum deflection was 2 mm. The driver's left and right femur maximum compressive forces were 1945 N and 1129 N, respectively.

The right front passenger's HIC was 1578. The right front passenger's chest maximum resultant acceleration with three (3) milliseconds minimum duration was 15.5 g. The right front passenger's chest maximum deflection was 3 mm. The right front passenger's left and right femur maximum compressive forces were 2067 kg and 2032 kg, respectively.

Following the impact, no fluid spilled from the vehicle's fuel system.

Table 1 Crash Test Summary

Test type:	80 kph rear impact with 70% overlap
Test date:	03/22/96
Test time:	1530
Ambient temperature at impact area:	-3° C
Vehicle year/make/ model/body style:	1996/Plymouth/Voyager/minivan
Vehicle test weight:	1946 kg
Impact angle[1]:	180°
Impact velocity[2]:	
Primary:	81.5 kph
Secondary:	81.6 kph
Maximum static crush:	435 mm
Number of cameras:	
High-speed:	13
Door opening data:	
Left-front:	Easy
Right-front:	Easy
Impact Location:	12 mm high of target center 6 mm left of target center

[1] With respect to tow track centerline.
[2] Speed trap measurement (± .08 kph accuracy)

Table 5 Fuel System Data

Vehicle year/make/model/body style:	1996/Plymouth/Voyager/minivan
Volpe No.:	RT0305
Fuel system capacity:	NA (from owner's manual)
Usable capacity:	67.4 liters (furnished by COTR)
Test volume range:	62.1 liters to 63.2 liters (92-94% of usable)
Actual test volume:	62.5 liters (with entire fuel system filled)
Test fluid type:	Stoddard solvent
Specific gravity:	0.764
Kinematic viscosity:	0.99 centistoke
Test fluid color:	purple
Type of fuel pump:	electric
Does the electric fuel pump operate with ignition switch "on" and the engine not operating.	No
Details of fuel system:	The fuel tank is located forward of the rear axle. The fuel filler neck is located on the left side. The fuel lines run along the right side to the front.

Table 6 FMVSS 301 Post-Impact Test Data

Test date: 03/22/96

Volpe No.: RT0305

Vehicle year/make/model/body style: 1996/Plymouth/Voyager/minivan

Test requirements:

Test vehicle fuel tank filled to 92 to 94% of manufacturer's usable capacity and with electric fuel pump operating (if it will operate without engine operation). Part 572 test dummies located at each front designated seating position.

Test vehicle impact type:

____ Frontal (48 kph)

____ Oblique (48 kph) with __° barrier face first contacting (driver's/passenger's) side

__X__ Rear moving barrier (80 kph)

____ Lateral moving barrier (32 kph)

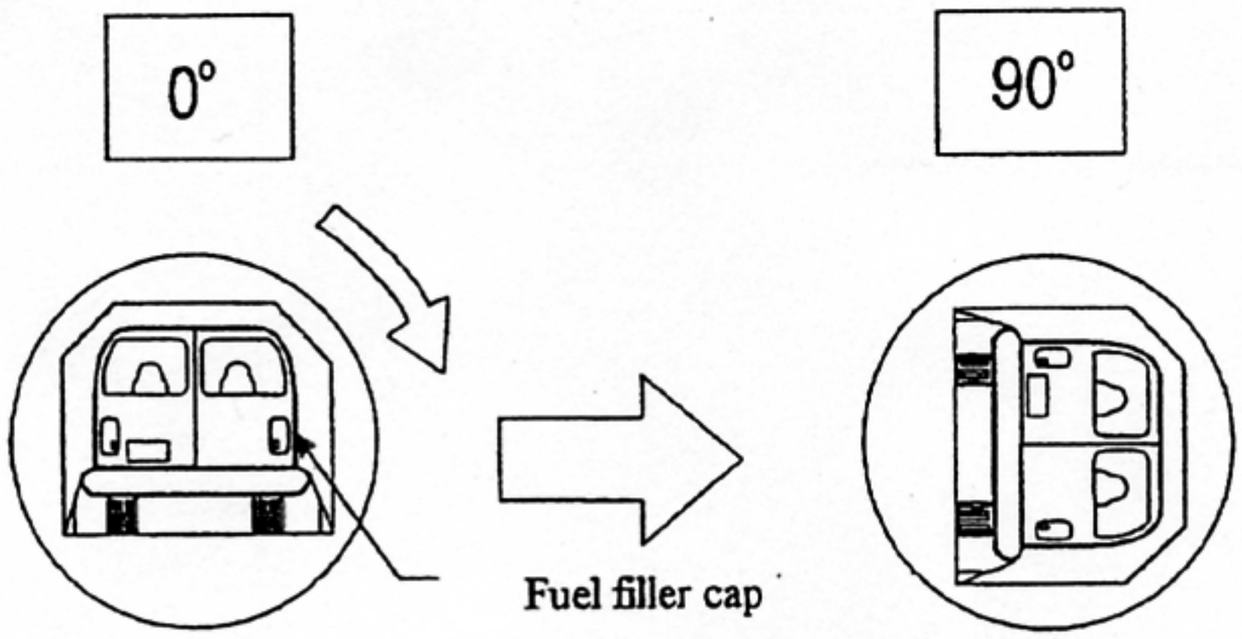
Fuel system fluid spillage measurements:

		Test Results	Maximum Allowable
1.	From impact until vehicle motion ceases	0 g	28 g
2.	5-Minute period after vehicle motion ceases	0 g	140 g
3.	Next 25 minutes after 5-minute period	0 g	28 g/1 min

Fuel system fluid spillage location(s): None

Figure 3 FMVSS 301 Static Rollover Test Data

Volpe No.: RT0305
Test phase



Static rollover machine rotation time information: (specified range is 1-3 minutes)

Time required for machine to rotate 90°	=	2	minutes,	0 seconds
FMVSS 301 position hold time	=	5	minutes,	0 seconds
Total	=	7	minutes,	0 seconds
Next whole minute interval	=	7	minutes	

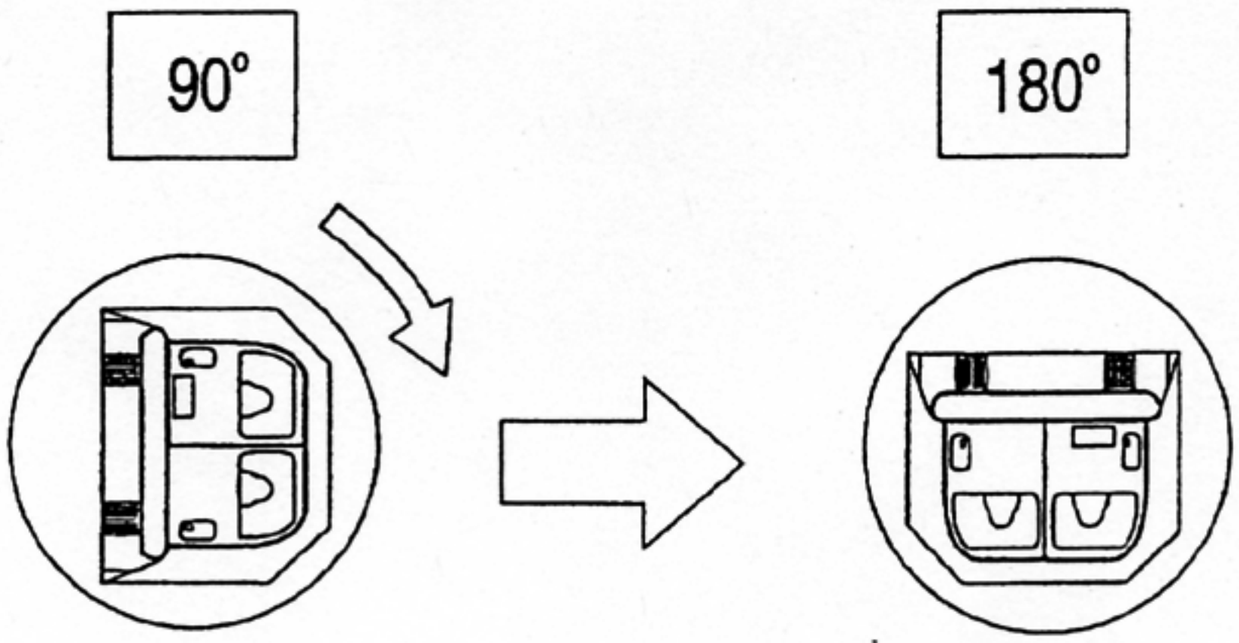
Fuel system fluid spillage measurements:

0° to 90° rotation (fuel filler cap down)	Test Results	Maximum Allowable
1. First five minutes from onset of rotation	0 g	142 g
2. Sixth minute from onset of rotation	0 g	28 g
3. Seventh minute from onset of rotation	0 g	28 g

Fuel system fluid spillage location(s): None

Figure 3 FMVSS 301 Static Rollover Test Data, Cont'd.

Test phase



Static rollover machine rotation time information: (specified range is 1-3 minutes)

Time required for machine to rotate 90°	=	2	minutes,	0	seconds
FMVSS 301 position hold time	=	5	minutes,	0	seconds
Total	=	7	minutes,	0	seconds
Next whole minute interval	=	14	minutes		

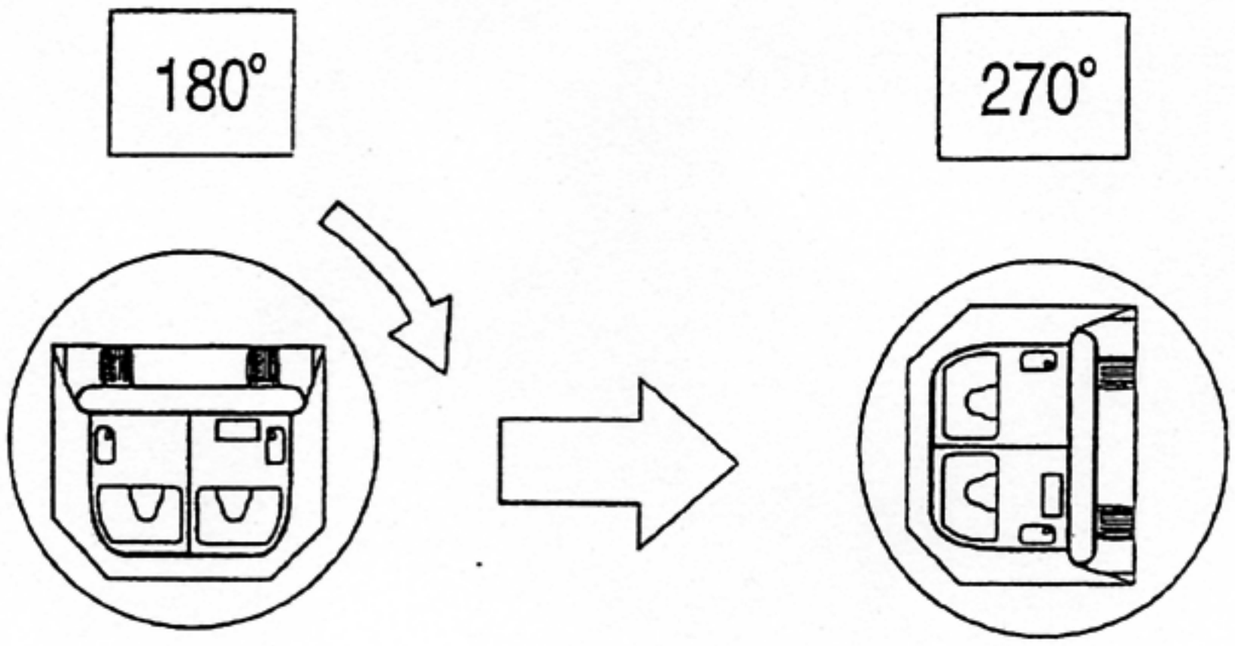
Fuel system fluid spillage measurements:

90° to 180° rotation	Test Results	Maximum Allowable
1. First five minutes from onset of rotation	0 g	142 g
2. Sixth minute from onset of rotation	0 g	28 g
3. Seventh minute from onset of rotation	0 g	28 g

Fuel system fluid spillage location(s): None

Figure 3 FMVSS 301 Static Rollover Test Data, Cont'd.

Test phase



Static rollover machine rotation time information: (specified range is 1-3 minutes)

Time required for machine to rotate 90°	=	2	minutes,	0 seconds
FMVSS 301 position hold time	=	5	minutes,	0 seconds
Total	=	7	minutes,	0 seconds
Next whole minute interval	=	21	minutes	

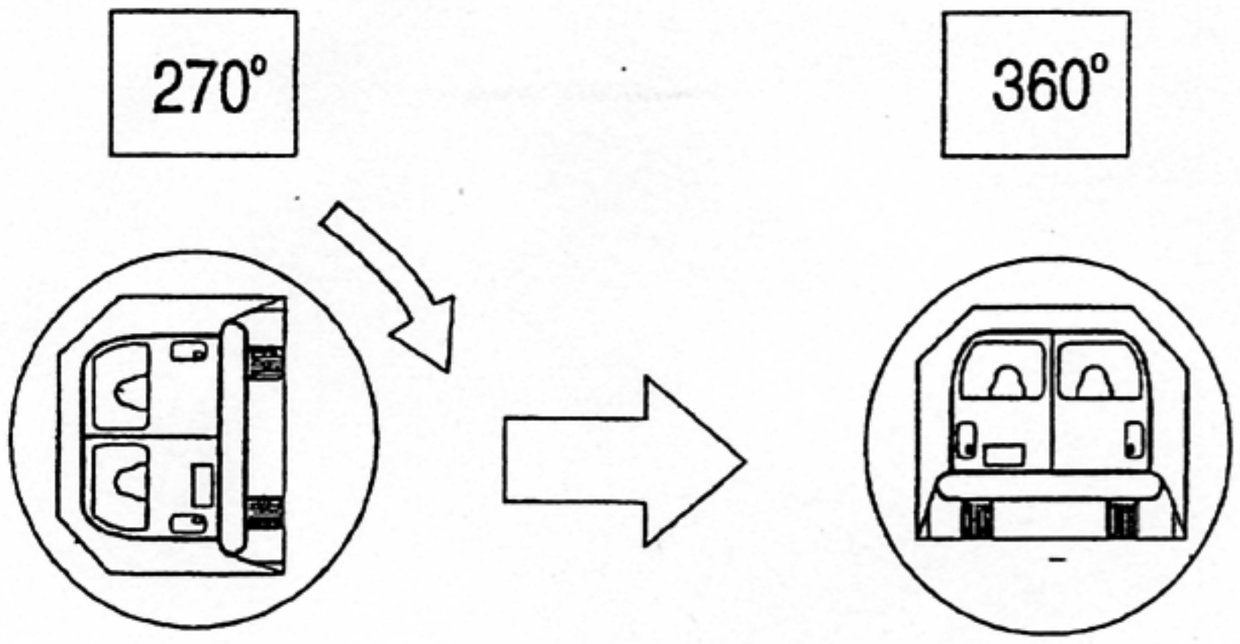
Fuel system fluid spillage measurements:

180° to 270° rotation	Test Results	Maximum Allowable
1. First five minutes from onset of rotation	0 g	142 g
2. Sixth minute from onset of rotation	0 g	28 g
3. Seventh minute from onset of rotation	0 g	28 g

Fuel system fluid spillage location(s): None

Figure 3 FMVSS 301 Static Rollover Test Data, Cont'd.

Test phase



Static rollover machine rotation time information: (specified range is 1-3 minutes)

Time required for machine to rotate 90°	=	2	minutes,	0 seconds
FMVSS 301 position hold time	=	5	minutes,	0 seconds
Total	=	7	minutes,	0 seconds
Next whole minute interval	=	28	minutes	

Fuel system fluid spillage measurements:

270° to 360° rotation	Test Results	Maximum Allowable
1. First five minutes from onset of rotation	0 g	142 g
2. Sixth minute from onset of rotation	0 g	28 g
3. Seventh minute from onset of rotation	0 g	28 g

Fuel system fluid spillage location(s): None