Memorandum

U.S. Department
of Transportation

**National Highway
Traffic Safety
Administration**

Subject: Motorcoach Safety Research
Motorcoach Sled Test Program.

Date: AUG 14 2008

From: Roger A. Saul, Ph.D.
Director, Office of Crashworthiness Standards

Reply to
Attn of:

To: Docket No. NHTSA-2007-28793

Thru: Anthony Cooke
Chief Counsel

Attached are the reports prepared by the MGA Research Corporation that contains the detailed test results on the roof crush and rollover testing that was performed on two 12,200 mm (40 feet) 1992 Motor Coach Industries (MCI) model MC-12, and two 12,200 mm (40 feet) 1991 Prevost model LeMirage motorcoaches. The vehicle and occupant instrumentation data, photographs, videos, and reports of the two rollover tests are also accessible from the NHTSA website. Follow the instruction below to access the data:

1. Go to the NHTSA homepage, http://www.nhtsa.dot.gov/,
2. Select the link "Vehicle Safety Research" on the upper right-hand side of the page.
3. From the resulting page, select "Databases and Software" under "Browse Topics" on the left.
4. From the "Interactive Access" option under "Vehicle Crash Test Database," select "Query by test parameters"
5. Enter test number 6359 or 6360 in the "Test No." box, and submit,
6. Or you may select "Query by vehicle parameters such as make, model and year"
7. Select MCI or Prevost from the "Vehicle Make" pull down box.

The reports, videos and photos may be downloaded from the "Multimedia" field in the resulting record. Instructions are also provided on the query results page for displaying additional detailed information, including downloads of individual sensor time history data traces from vehicle and occupant instrumentation.

Attachments:
FMVSS 220 Based Research Test of Motor Coach Roof Strength: 1991 Prevost LeMirage Motor Coach; Report Number: 220-MGA-2007-003R
FMVSS No. 220 Based Research Test of Motor Coach Roof Strength 1992 MCI MC-12 Motor Coach; Report Number: 220-MGA-2007-002R
ECE Regulation 66 Based Research Test of Motor Coach Roof Strength 1991 Prevost LeMirage Motor Coach; Report Number: ECE 66-MGA-2007-002
ECE Regulation 66 Based Research Test of Motor Coach Roof Strength 1992 MCI MC-12 Motor Coach; Report Number: ECE 66-MGA-2007-001

REPORT NUMBER: 220-MGA-2007-002R

FMVSS 220 BASED RESEARCH TEST OF MOTOR COACH ROOF STRENGTH

1992 MCI MC-12 MOTOR COACH
NHTSA NO.: CN0800

PREPARED BY:
MGA RESEARCH CORPORATION
5000 WARREN ROAD
BURLINGTON, WI 53105

FINAL REPORT DATE: MAY 7, 2008

FINAL REPORT

PREPARED FOR:
U.S. DEPARTMENT OF TRANSPORTATION
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION
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Prepared by: _____ Date: May 7, 2008
James Hansen, Project Engineer

Reviewed by: _____ Date: May 7, 2008
Michael Janovicz, Program Manager

FINAL REPORT ACCEPTED BY:

_____

5/07/08
Date of Acceptance

_____

5/07/08
Date of Acceptance

Technical Report Documentation Page

1. Report No. 220-MGA-2007-002R	*2. Government Accession No.*	*3. Recipient's Catalog No.*	
4. Title and Subtitle Final Report of FMVSS 220 Research Testing of 1992 MCI MC-12 MOTOR COACH NHTSA No.: CN0800		*5. Report Date* May 7, 2008 *6. Performing Organization Code* MGA	
7. Author(s) James Hansen, Project Engineer Michael Janovicz, Program Manager		*8. Performing Organization Report No.* 220-MGA-2007-002R	
9. Performing Organization Name and Address MGA Research Corporation 5000 Warren Road Burlington, WI 53105		*10. Work Unit No.* *11. Contract or Grant No.* DTNH22-02-D-01057	
12. Sponsoring Agency Name and Address U.S. Department of Transportation National Highway Traffic Safety Administration Enforcement Office of Vehicle Safety Compliance Mail Code: NVS-220 1200 New Jersey Avenue, S.E. Washington, D.C. 20590		*13. Type of Report and Period Covered* Final Report February 2008 – May 2008 *14. Sponsoring Agency Code* NVS-220	
15. Supplementary Notes			
16. Abstract A FMVSS 220 based research test of motor coach roof strength was conducted on the subject 1992 MCI MC-12 motor coach, NHTSA No. CN0800. The test procedure was based on the Office of Vehicle Safety Compliance Test Procedure No. TP-220-02 with the following modifications: ● The roof crush test was not limited by displacement. The test was allowed to continue as long as the applied load was 1.5 times the unloaded vehicle weight or less. ● The roof crush was paused at increments of 0.5 times the unloaded vehicle weight to allow emergency exit operation assessment. ● Residual space templates, as defined in the Economic Commission of Europe Regulation 66 (ECE-R66), were installed in the vehicle.			
17. Key Words Research Testing Safety Engineering FMVSS 220 Motor Coach		*18. Distribution Statement* Copies of this report are available from: National Highway Traffic Safety Administration Technical Information Services Division NPO-411 1200 New Jersey Avenue SE Room E12-100 Washington, DC 20590 Email: tis@nhtsa.dot.gov FAX: 202-493-2833	
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SECTION 1
PURPOSE OF RESEARCH TEST

Federal Motor Vehicle Safety Standard (FMVSS) 220, School Bus Rollover Protection, was used as a guide for this research test. The purpose of this test was to explore the practicability of the FMVSS 220 test for motor coach applications, to gather research data regarding the roof strength and structural integrity of motor coach buses, to gather occupant residual space data, and to record the test effects on windows and emergency exits.

SECTION 2
TEST SUMMARY

This test was performed at the MGA Research Corporation Proving Grounds in Burlington Wisconsin. Federal Motor Vehicle Safety Standard (FMVSS) 220, School Bus Rollover Protection, was used as a guide for this research test. Significant changes from the base FMVSS 220 test are as follows:

- Wooden templates meeting the dimensional specifications shown in Economic Commission of Europe - Regulation 66 - Figure 2 were installed in the bus at the front, middle, and rear of the passenger compartment to determine if any portion of the bus entered the residual space as defined in ECE Reg. 66, Section 5.2.
- Roof loading was allowed to continue until either a force of 1.5 x UVW or the maximum displacement range of the test device was reached, which ever came first.
- Roof loading was paused momentarily at force levels of 0.5, 1.0 and 1.5 x UVW to allow emergency exit operation assessment (per FMVSS 217). The operating forces of all the emergency windows were recorded pre-test, during the test (if possible), and post-test.

A computer controlled force application device designed and built by MGA Research Corporation was used for the test. The length of the force application plate was adjusted to approximately 12 inches less than the length of the vehicle roof in accordance with FMVSS 220. Two load beams were located underneath the vehicle at locations where significant frame structure was accessible. Four hydraulic actuators were attached to the load beams to lift the vehicle to the force application plate and apply the test load. The target maximum roof load was determined according to FMVSS 220 by multiplying the approximate Unloaded Vehicle Weight (UVW) by 1.5. The UVW was obtained from two sources: the MCI MC-12 specification sheet and the load cell reading of the force application device. Video was used to determine if any contact occurred between the vehicle interior and the residual space templates during the test.

SECTION 2 (CONTINUED)
TEST SUMMARY

A 2224 N pre-load was applied evenly across the vehicle roof prior to the force application. The vertical movement of the force application plate relative to the load beams was measured from this initial, pre-loaded condition. The roof loading was paused momentarily at a force of 0.5 x UVW in order to measure the forces required to operate the emergency exits (see Data Sheet 3). The loading was continued and the force application device reached its maximum displacement range before a force of 1.0 x UVW could be met. A peak force of 0.91 x UVW was achieved during the test. Contact was made between the front residual space template and the left and right luggage racks approximately 13 seconds after the peak force was recorded. The test results are summarized in the following table.

Test UVW[(1)]	12,700 kg
Calculated Target Maximum Roof Load = 1.5 * UVW[(1)]:	19,050 kg
Maximum Roof Load Achieved During the Test:	11,714 kg
Average Roof Deflection at Maximum Load Achieved During the Test:	391 mm
Maximum Roof Deflection (measured at any single one of the four cylinders):	654 mm
Residual Template Contact:	YES[(2)]
Additional Test Observations:	The right front windshield fully lost retention and the left front windshield partially lost retention during the test. Windshield retention was lost just prior to reaching the maximum achieved load.

NOTES:
(1) This value was used for the maximum roof load calculation and is based on the UVW determined from the force application device, rounded up to 12,700 (28,000 lb).
(2) The left and right luggage racks contacted the foremost residual space template (T_1) prior to reaching the calculated maximum roof load.

SECTION 3
VEHICLE INFORMATION

COMPLETED VEHICLE	
Manufacturer:	Motor Coach Industries, Inc.
Make/Model:	MC-12
VIN:	1M8RCM7AXNP044902
NHTSA No.:	CN0800
Color:	White and Blue
GVWR (kg/lb):	17,146 kg / 37,800 lbs
Build Date:	10/1992
Certification Date:	10/1992

DATES	
Vehicle Receipt:	October 11, 2007
Test Date:	February 26, 2008

BUS UNLOADED VEHICLE WEIGHT (UVW)	
From MCI MC-12 Specsheet	12,474 kg
From Force Application Device	12,634 kg

BUS ROOF AND APPLICATION PLATE DATA			
Dimensions	Bus Roof	Calculated Roof Plate	Actual Roof Plate
Length (mm):	11311	11006	10973
Width (mm):	2438	914	914

Notes: The vehicle was centered laterally and longitudinally under the load application plate.

Bus Construction:	--	Rigid Frame	X	Unibody (monocoque)

Components Removed From Vehicle Before Testing:	Roof Exit and Running Lights Tag Axle Wheels [1] Seat Components [2]

COMMENTS:

[1] The tag axle wheels were removed to facilitate placement of the rear load beam on a strong portion of the vehicle structure. The wheels were placed inside the vehicle so that they would be accounted for in the UVW measurement.

[2] Some seat components in the vicinity of the residual space templates were removed to allow the installation of the templates. The weight of these components did not contribute significantly to the UVW measurement.

SECTION 4
RESEARCH TEST DATA

The following data sheets document the results of FMVSS 220 based testing of the 1992 MCI MC-12 motor coach, NHTSA No. CN0800.

DATA SHEET 1

FORCE APPLICATION AND DEFLECTION INFORMATION

Test Vehicle: **1992 MCI MC-12 MOTOR COACH** NHTSA No.: **CN0800**
Test Lab: **MGA RESEARCH CORPORATION** Test Date: **2/25/08**

Unloaded Delivered Weight (UVW): (kg)	12,700 kg
Calculated Test Load = 1.5 * UVW	19,050 kg[(1)]
Maximum Deflection at 0.5 * UVW	76 mm
Maximum Deflection at 1.0 * UVW	N/A[(1)]
Maximum Deflection at 1.5 * UVW	N/A[(1)]
Maximum Roof Load Achieved	11,714 kg
Roof Deflection at Maximum Achieved Load	391 mm
Maximum Roof Deflection	654 mm

		Pre-Load (227 kg)	Maximum[(1)]	
		Deflection (mm)	Deflection (mm)	Load (kg)
Cylinder	1 (right front)	0	664	2,951
	2 (left front)	0	653	2,935
	3 (right rear)	0	100	2,940
	4 (left rear)	0	149	2,953
Total Load				11,707
Average Deflection			391	

COMMENTS:
[(1)] The target maximum roof load was not achieved before the force application device reached its maximum displacement limit. The force application was stopped at approximately 61% of the target load.

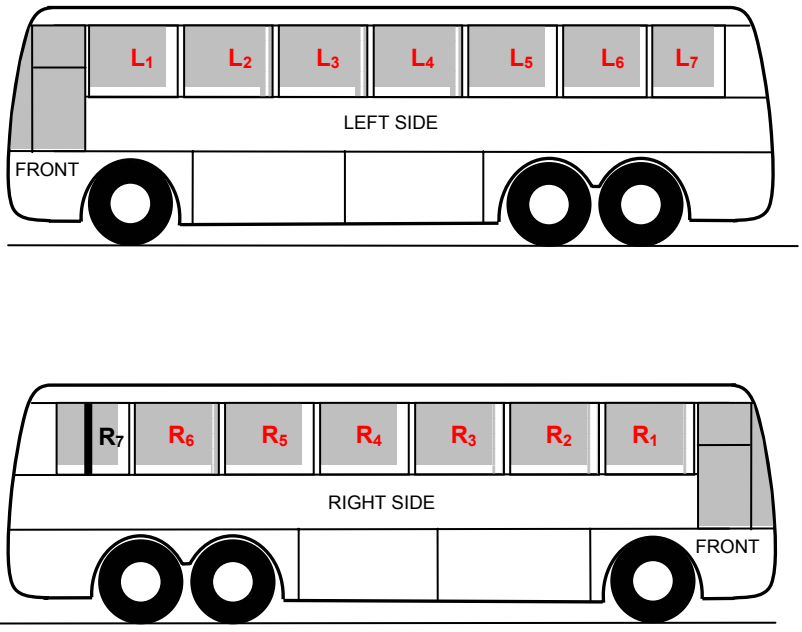
DATA SHEET 2

FORCES TO UNLATCH AND OPEN THE EMERGENCY EXITS

Test Vehicle: **1992 MCI MC-12 MOTOR COACH** NHTSA No.: **CN0800**
Test Lab: **MGA RESEARCH CORPORATION** Test Date: **2/25/08**

Can all exits be manually released and extended by a single person without tools, remote controls, and without the engine running?	**YES**

Diagram of Emergency Exits



Emergency Exits are noted with **RED** text

DATA SHEET 3

EMERGENCY EXIT UNLATCHING AND OPENING FORCE TESTS (INTERIOR)

Test Vehicle: **1992 MCI MC-12 MOTOR COACH** NHTSA No.: **CN0800**
Test Lab: **MGA RESEARCH CORPORATION** Test Date: **2/25/08**

FORCE TO UNLATCH THE EMERGENCY EXITS (INTERIOR)

Exit Location	Maximum Force (FMVSS 217)	Force at Pre-Test (N)	Force at 0.5 x UVW Roof Load (N) [1]	Force at 1.0 x UVW Roof Load (N) [2]	Force at 1.5 x UVW Roof Load (N) [2]	Force at Post-Test (N)	Type of Motion
L1	267 N	57.8	< 267	N/A	N/A	39.2	Rotary
L2	267 N	61.5	< 267	N/A	N/A	52.6	Rotary
L3	267 N	42.2	< 267	N/A	N/A	55.0	Rotary
L4	267 N	67.5	< 267	N/A	N/A	66.9	Rotary
L5	267 N	39.2	< 267	N/A	N/A	41.0	Rotary
L6	267 N	88.5	< 267	N/A	N/A	86.2	Rotary
L7	267 N	46.5	< 267	N/A	N/A	44.5	Rotary
R1	267 N	44.2	< 267	N/A	N/A	38.2	Rotary
R2	267 N	35.6	< 267	N/A	N/A	37.4	Rotary
R3	267 N	48.6	< 267	N/A	N/A	49.7	Rotary
R4	267 N	63.5	< 267	N/A	N/A	60.1	Rotary
R5	267 N	84.2	< 267	N/A	N/A	77.5	Rotary
R6	267 N	55.7	< 267	N/A	N/A	52.1	Rotary

COMMENTS:
[1] In the interest of test personnel safety, individual force measurements were not recorded. In order to reduce the time that test personnel were inside of the test vehicle while the roof was under load, the latch mechanisms were operated by hand while applying a force no greater than 267 N. There was no perceptible increase in the forces required to unlatch the exits at 0.5 x UVW roof load over those of the pre-test condition.
[2] The force application device reached its maximum displacement limit before the roof load could be achieved.

DATA SHEET 3 (CONTINUED)

EMERGENCY EXIT UNLATCHING AND OPENING FORCE TESTS (INTERIOR)

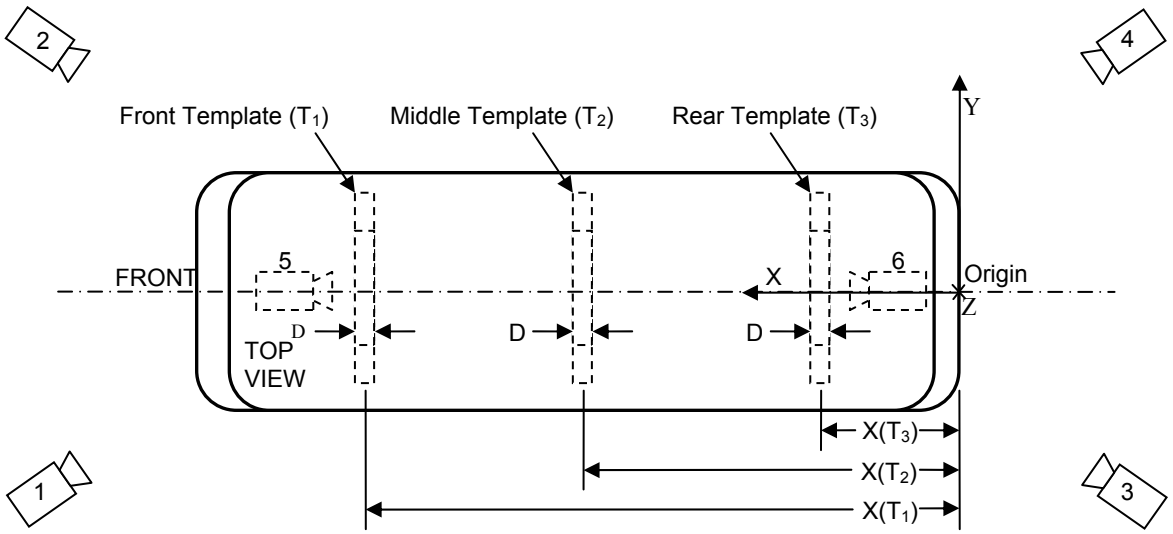
FORCE TO OPEN THE EMERGENCY EXITS (INTERIOR)

Exit Location	Maximum Force (FMVSS 217)	Force at Pre-Test (N)	Force at 0.5 x UVW Roof Load (N)	Force at 1.0 x UVW Roof Load (N) [1]	Force at 1.5 x UVW Roof Load (N) [1]	Force at Post-Test (N)	Type of Motion
L1	267 N	261.1	177.9	N/A	N/A	166.8	Straight
L2	267 N	136.6	191.2	N/A	N/A	243.3 [2]	Straight
L3	267 N	121.0	160.1	N/A	N/A	189.5	Straight
L4	267 N	145.0	169.0	N/A	N/A	252.7 [2]	Straight
L5	267 N	156.6	169.0	N/A	N/A	45.4	Straight
L6	267 N	201.5	280.2	N/A	N/A	381.2 [2]	Straight
L7	267 N	88.5	102.3	N/A	N/A	116.5	Straight
R1	267 N	104.5	133.4	N/A	N/A	188.2	Straight
R2	267 N	147.7	142.3	N/A	N/A	403.5 [2]	Straight
R3	267 N	272.2	293.6	N/A	N/A	409.2 [2]	Straight
R4	267 N	152.1	195.7	N/A	N/A	426.1 [2]	Straight
R5	267 N	130.8	226.9	N/A	N/A	65.4	Straight
R6	267 N	138.8	226.9	N/A	N/A	197.5	Straight

COMMENTS:
[1] The force application device reached its maximum displacement limit before the roof load could be achieved.
[2]The force to push the exit open increased due the window sash binding within the window frame.

DATA SHEET A1

REAL-TIME CAMERAS AND RESIDUAL SPACE TEMPLATES



REAL-TIME CAMERAS

Number	View	Location (mm, from origin to camera focal plane)		
		X	Y	Z†
1*	Left Front Quarter Overall at Roof Height	-	-	-
2	Right Front Quarter Overall at Mid-Height	-	-	-
3	Left Rear Quarter Overall at Roof Height	-	-	-
4*	Right Rear Quarter at Mid-Height	-	-	-
5	Rear Interior	1704	0	1470
6	Front Interior	11556	0	1470

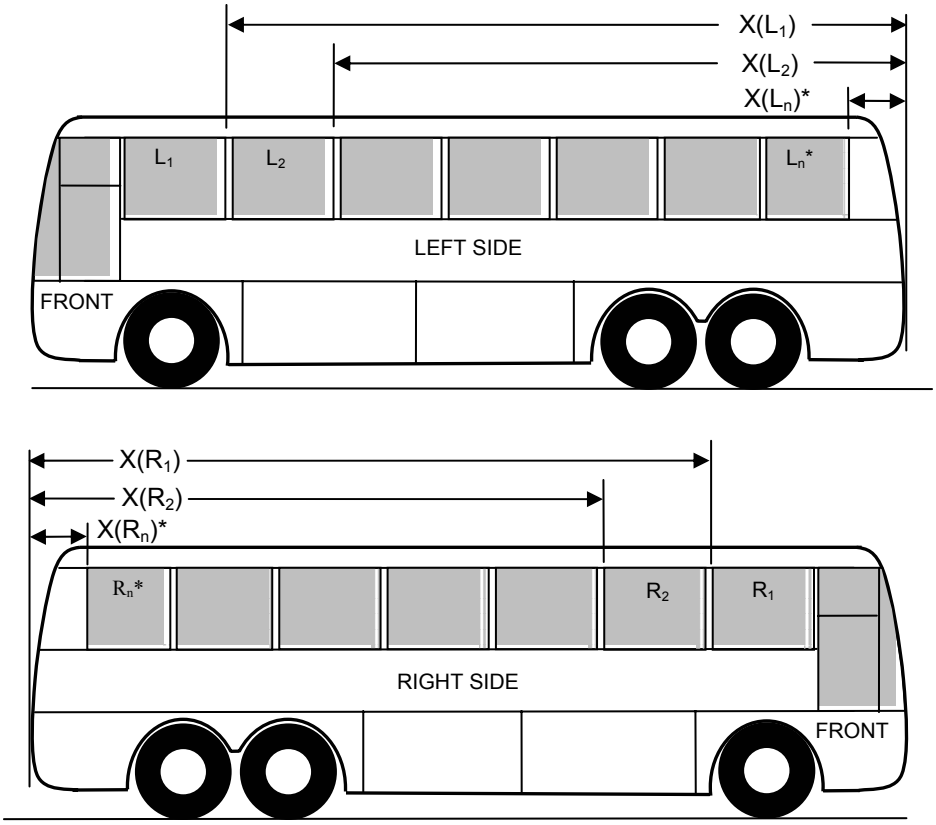
Coordinate System: X positive forward, Y positive right, Z positive down
† Height above bus floor for interior cameras.
* Include if additional real time cameras are available.

RESIDUAL SPACE TEMPLATE MEASUREMENTS

Measurement	Dimension (mm)
Template Depth (D)	70
Bus Rearmost Surface to Center of Front Template ($X(T_1)$)	9,796
Bus Rearmost Surface to Center of Middle Template ($X(T_2)$)	6,316
Bus Rearmost Surface to Center of Rear Template ($X(T_3)$)	2,244

DATA SHEET A2

SIDE WINDOW DATA



* n = Side window number

DATA SHEET A2 (CONTINUED)

SIDE WINDOW DATA

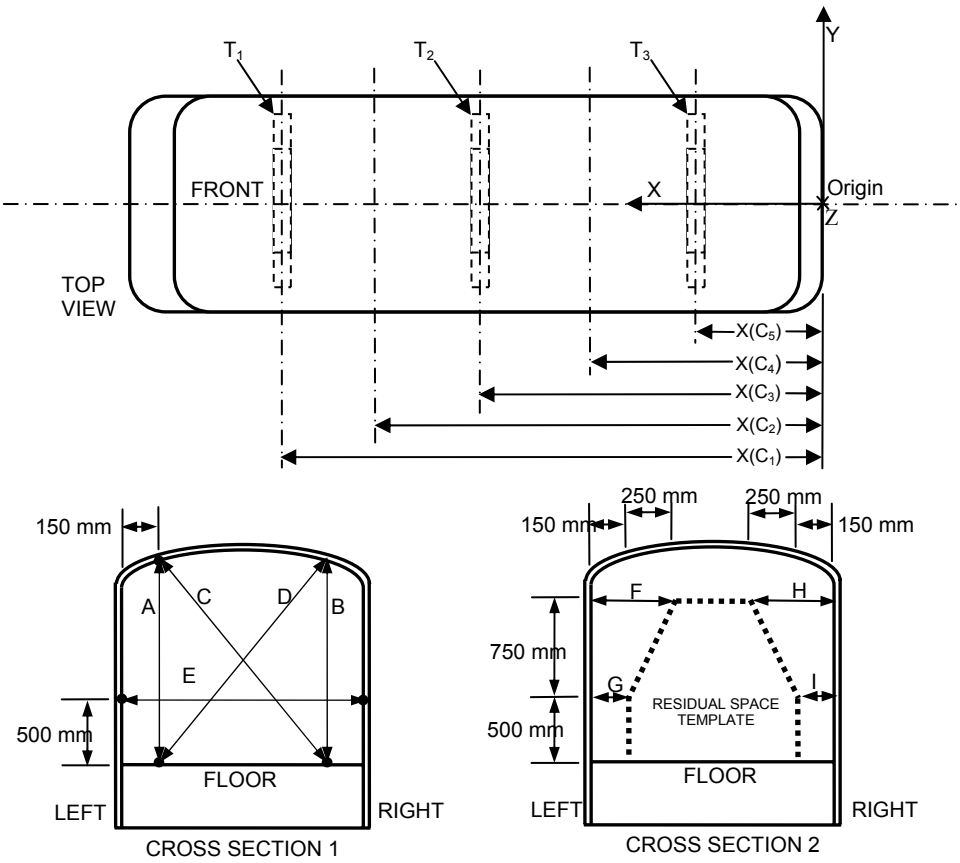
WINDOW SIZE, LOCATION, AND TYPE

Window Location	Window Max. Length (mm)	Window Max. Height (mm)	Window Periphery (mm)	Bus Rearmost Surface to Window Trailing Edge $X(L_n)$*, $X(R_n)$* (mm)	Window Trailing Edge Pillar Width (mm)	Window Type	Emergency Exit Hinge and Latch Location		Comments
							Hinge	Latch	
L_1	1310	685	3990	9486	57	Emergency Exit	Top	Bottom	(1)
L_2	1310	685	3990	8015	57	Emergency Exit	Top	Bottom	(1)
L_3	1310	685	3990	6545	57	Emergency Exit	Top	Bottom	(1)
L_4	1310	685	3990	5064	57	Emergency Exit	Top	Bottom	(1)
L_5	1310	685	3990	3600	57	Emergency Exit	Top	Bottom	(1)
L_6	1310	685	3990	2114	57	Emergency Exit	Top	Bottom	(1)
L_7	1310	685	3990	634	57	Emergency Exit	Top	Bottom	(1)
R_1	1310	685	3990	9486	57	Emergency Exit	Top	Bottom	(1)
R_2	1310	685	3990	8015	57	Emergency Exit	Top	Bottom	(1)
R_3	1310	685	3990	6545	57	Emergency Exit	Top	Bottom	(1)
R_4	1310	685	3990	5064	57	Emergency Exit	Top	Bottom	(1)
R_5	1310	685	3990	3600	57	Emergency Exit	Top	Bottom	(1)
R_6	1310	685	3990	2114	57	Emergency Exit	Top	Bottom	(1)
R_7	1310	685	3990	634	57	Fixed	--	--	(2)

COMMENTS:
(1) The emergency exit window was a sash and frame design. When closed, the window sash rested fully within the inside perimeter of the window frame.
(2) This window was divided between the passenger compartment and the vehicle's restroom. The window was 1310 mm wide with 315 mm adjacent to the restroom and 995 mm adjacent to the passenger compartment.

DATA SHEET A3

CROSS SECTION LOCATIONS AND STATIC MEASUREMENTS



CROSS SECTION LOCATIONS AND STATIC MEASUREMENTS

Cross Section	Bus Rearmost Surface to Cross Section $X(C_n)$* (mm)	Interior Dimensions (mm)														
		Pre-Test					At Maximum Load[1]					Post-Test				
		A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
C_1 (Center of T_1)	9796	1879	1877	2626	2629	2289	N/A	N/A	N/A	N/A	N/A	1803	1791	2693	2694	2328
C_2 (Mid T_1 and T_2)	8170	1857	1858	2630	2632	2297	N/A	N/A	N/A	N/A	N/A	1788	1777	2701	2784	2328
C_3 (Center of T_2)	6316	1847	1842	2602	2604	2300	N/A	N/A	N/A	N/A	N/A	1794	1799	2693	2750	2338
C_4 (Mid T_2 and T_3)	4112	1818	1821	2595	2598	2301	N/A	N/A	N/A	N/A	N/A	1805	1780	2662	2614	2314
C_5 (Center of T_3)	2244	1809	1797	2591	2600	2293	N/A	N/A	N/A	N/A	N/A	1802	1792	2585	2587	2300

* n = Cross section number

COMMENTS:

[1] These measurements were not taken since the force application device reached its maximum displacement limit before the maximum roof load could be achieved.

DATA SHEET A3 (CONTINUED)

CROSS SECTION LOCATIONS AND STATIC MEASUREMENTS

RESIDUAL SPACE TEMPLATES TO SIDE WALL MEASUREMENTS (mm)

Template	Pre-Test				At Maximum Load[1]				Post-Test			
	Left		Right		Left		Right		Left		Right	
	Top Corner (F)	Bottom Corner (G)	Top Corner (H)	Bottom Corner (I)	Top Corner (F)	Bottom Corner (G)	Top Corner (H)	Bottom Corner (I)	Top Corner (F)	Bottom Corner (G)	Top Corner (H)	Bottom Corner (I)
T_1	400	150	397	147	N/A	N/A	N/A	N/A	417	167	406	156
T_2	400	150	406	156	N/A	N/A	N/A	N/A	410	160	425	175
T_3	400	150	455	155	N/A	N/A	N/A	N/A	400	150	410	160

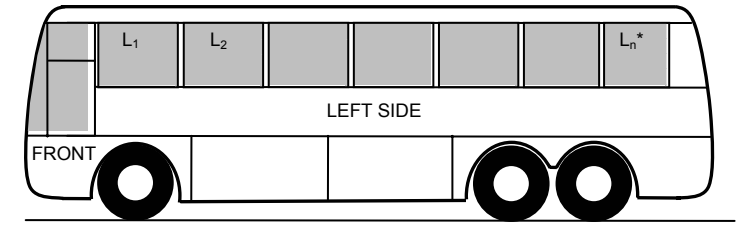
COMMENTS:
[1] These measurements were not taken since the force application device reached its maximum displacement limit before the maximum roof load could be achieved.

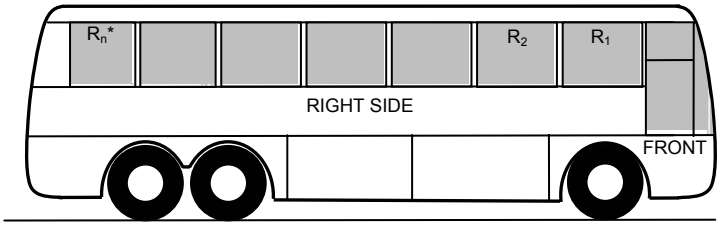
DATA SHEET A4

WINDOW RETENTION

Retention loss identified during test: ____ Yes __X__ No

If “Yes”, indicate where and approximately how much of the window experienced retention loss.





* n = Side window number

POST-TEST WINDOW PERFORMANCE

Window Location	Window Retention (full/partial/none)	Glazing Thickness (if retention was lost)	Window Periphery (mm)	Comments
L_1	Full Retention	--	3990	--
L_2	Full Retention	--	3990	--
L_3	Full Retention	--	3990	--
L_4	Full Retention	--	3990	--
L_5	Full Retention	--	3990	--
L_6	Full Retention	--	3990	--
L_7	Full Retention	--	3360	--
R_1	Full Retention	--	3990	--
R_2	Full Retention	--	3990	--
R_3	Full Retention	--	3990	--
R_4	Full Retention	--	3990	--
R_5	Full Retention	--	3990	--
R_6	Full Retention	--	3990	--
R_7	Full Retention	--	3990	--

APPENDIX A
PHOTOGRAPHS

TABLE OF PHOTOGRAPHS

Test Vehicle: **1992 MCI MC-12 MOTOR COACH** NHTSA No.: **CN0800**
Test Lab: **MGA RESEARCH CORPORATION** Test Date: **02/25/08**

Right Front ¾ View of Bus (Received)

Test Vehicle:	**1992 MCI MC-12 MOTOR COACH**	NHTSA No.:	**CN0800**
Test Lab:	**MGA RESEARCH CORPORATION**	Test Date:	**02/25/08**

Right Rear ¾ View of Bus (Received)

Test Vehicle: **1992 MCI MC-12 MOTOR COACH** NHTSA No.: **CN0800**
Test Lab: **MGA RESEARCH CORPORATION** Test Date: **02/25/08**

Close Up View of Certification Label

Test Vehicle:	**1992 MCI MC-12 MOTOR COACH**	NHTSA No.:	**CN0800**
Test Lab:	**MGA RESEARCH CORPORATION**	Test Date:	**02/25/08**

Pre-Test Front View of Bus (Received)

Test Vehicle:	**1992 MCI MC-12 MOTOR COACH**	NHTSA No.:	**CN0800**
Test Lab:	**MGA RESEARCH CORPORATION**	Test Date:	**02/25/08**

Pre-Test Rear View of Bus (Received)

Test Vehicle:	**1992 MCI MC-12 MOTOR COACH**	NHTSA No.:	**CN0800**
Test Lab:	**MGA RESEARCH CORPORATION**	Test Date:	**02/25/08**

Pre-Test Right Side View of Bus (Received)

Test Vehicle: **1992 MCI MC-12 MOTOR COACH** NHTSA No.: **CN0800**
Test Lab: **MGA RESEARCH CORPORATION** Test Date: **02/25/08**

Pre-Test Right Side Window 1 Exterior View

Pre-Test Right Side Window 2 Exterior View

Test Vehicle:	**1992 MCI MC-12 MOTOR COACH**	NHTSA No.:	**CN0800**
Test Lab:	**MGA RESEARCH CORPORATION**	Test Date:	**02/25/08**

Pre-Test Right Side Window 3 Exterior View

Pre-Test Right Side Window 4 Exterior View

Pre-Test Right Side Window 5 Exterior View

Pre-Test Right Side Window 6 Exterior View

Test Vehicle:	**1992 MCI MC-12 MOTOR COACH**	NHTSA No.:	**CN0800**
Test Lab:	**MGA RESEARCH CORPORATION**	Test Date:	**02/25/08**

Pre-Test Right Side Window 7 Exterior View

Pre-Test Left Side Window 1 Exterior View

Pre-Test Left Side Window 2 Exterior View

Pre-Test Left Side Window 3 Exterior View

Test Vehicle: **1992 MCI MC-12 MOTOR COACH** NHTSA No.: **CN0800**
Test Lab: **MGA RESEARCH CORPORATION** Test Date: **02/25/08**

Pre-Test Left Side Window 4 Exterior View

Pre-Test Left Side Window 5 Exterior View

Test Vehicle:	**1992 MCI MC-12 MOTOR COACH**	NHTSA No.:	**CN0800**
Test Lab:	**MGA RESEARCH CORPORATION**	Test Date:	**02/25/08**

Pre-Test Left Side Window 6 Exterior View

Pre-Test Left Side Window 7 Exterior View

Pre-Test Front Door (Exterior)

Test Vehicle: **1992 MCI MC-12 MOTOR COACH**
Test Lab: **MGA RESEARCH CORPORATION**

NHTSA No.: **CN0800**
Test Date: **02/25/08**

Pre-Test Template 1 Clearance

Test Vehicle: **1992 MCI MC-12 MOTOR COACH** NHTSA No.: **CN0800**
Test Lab: **MGA RESEARCH CORPORATION** Test Date: **02/25/08**

Pre-Test Template 2 Clearance

Test Vehicle: **1992 MCI MC-12 MOTOR COACH** NHTSA No.: **CN0800**
Test Lab: **MGA RESEARCH CORPORATION** Test Date: **02/25/08**

Pre-Test Template 3 Clearance

Pre-Test Close up View of Right Side Window 7 Damage

Test Vehicle:	**1992 MCI MC-12 MOTOR COACH**	NHTSA No.:	**CN0800**
Test Lab:	**MGA RESEARCH CORPORATION**	Test Date:	**02/25/08**

Pre-Load Right Front Side of Bus (Exterior)

Test Vehicle:	**1992 MCI MC-12 MOTOR COACH**	NHTSA No.:	**CN0800**
Test Lab:	**MGA RESEARCH CORPORATION**	Test Date:	**02/25/08**

Pre-Load Left Side ¾ View of Bus (Exterior)

Test Vehicle:	**1992 MCI MC-12 MOTOR COACH**	NHTSA No.:	**CN0800**
Test Lab:	**MGA RESEARCH CORPORATION**	Test Date:	**02/25/08**

Pre-Load Right Rear Side View of Bus (Exterior)

Test Vehicle:	**1992 MCI MC-12 MOTOR COACH**	NHTSA No.:	**CN0800**
Test Lab:	**MGA RESEARCH CORPORATION**	Test Date:	**02/25/08**

Pre-Load Rear View of Bus (Exterior)

Test Vehicle: **1992 MCI MC-12 MOTOR COACH** NHTSA No.: **CN0800**
Test Lab: **MGA RESEARCH CORPORATION** Test Date: **02/25/08**

Full-Load Front ¾ View of Bus (Exterior)

Test Vehicle:	**1992 MCI MC-12 MOTOR COACH**	NHTSA No.:	**CN0800**
Test Lab:	**MGA RESEARCH CORPORATION**	Test Date:	**02/25/08**

Full-Load Right Front Side View of Bus (Exterior)

Test Vehicle:	**1992 MCI MC-12 MOTOR COACH**	NHTSA No.:	**CN0800**
Test Lab:	**MGA RESEARCH CORPORATION**	Test Date:	**02/25/08**

Post-Test Front View of Bus (Exterior)

Test Vehicle:	**1992 MCI MC-12 MOTOR COACH**	NHTSA No.:	**CN0800**
Test Lab:	**MGA RESEARCH CORPORATION**	Test Date:	**02/25/08**

Post-Test Front View of Bus Roof Close Up (Exterior)

Test Vehicle:	**1992 MCI MC-12 MOTOR COACH**	NHTSA No.:	**CN0800**
Test Lab:	**MGA RESEARCH CORPORATION**	Test Date:	**02/25/08**

Post-Test Rear View of Bus Roof Close Up (Exterior)

Test Vehicle: **1992 MCI MC-12 MOTOR COACH**
Test Lab: **MGA RESEARCH CORPORATION**

NHTSA No.: **CN0800**
Test Date: **02/25/08**

Post-Test Rear View of Bus Roof (Interior)

Test Vehicle: **1992 MCI MC-12 MOTOR COACH**
Test Lab: **MGA RESEARCH CORPORATION**

NHTSA No.: **CN0800**
Test Date: **02/25/08**

Post-Test Front View of Bus Roof (Interior)

Post-Test Right Side Window 1 Exterior View

Post-Test Right Side Window 2 Exterior View

Post-Test Right Side Window 3 Exterior View

Test Vehicle: **1992 MCI MC-12 MOTOR COACH** NHTSA No.: **CN0800**
Test Lab: **MGA RESEARCH CORPORATION** Test Date: **02/25/08**

Post-Test Right Side Window 4 Exterior View

Test Vehicle:	**1992 MCI MC-12 MOTOR COACH**	NHTSA No.:	**CN0800**
Test Lab:	**MGA RESEARCH CORPORATION**	Test Date:	**02/25/08**

Post-Test Right Side Window 5 Exterior View

Test Vehicle:	**1992 MCI MC-12 MOTOR COACH**	NHTSA No.:	**CN0800**
Test Lab:	**MGA RESEARCH CORPORATION**	Test Date:	**02/25/08**

Post-Test Right Side Window 6 Exterior View

Post-Test Right Side Window 7 Exterior View

Test Vehicle:	**1992 MCI MC-12 MOTOR COACH**	NHTSA No.:	**CN0800**
Test Lab:	**MGA RESEARCH CORPORATION**	Test Date:	**02/25/08**

Post-Test Left Side Window 1 Exterior View

Test Vehicle: **1992 MCI MC-12 MOTOR COACH** NHTSA No.: **CN0800**
Test Lab: **MGA RESEARCH CORPORATION** Test Date: **02/25/08**

Post-Test Left Side Window 2 Exterior View

Test Vehicle:	**1992 MCI MC-12 MOTOR COACH**	NHTSA No.:	**CN0800**
Test Lab:	**MGA RESEARCH CORPORATION**	Test Date:	**02/25/08**

Post-Test Left Side Window 3 Exterior View

Post-Test Left Side Window 4 Exterior View

Test Vehicle:	**1992 MCI MC-12 MOTOR COACH**	NHTSA No.:	**CN0800**
Test Lab:	**MGA RESEARCH CORPORATION**	Test Date:	**02/25/08**

Post-Test Left Side Window 5 Exterior View

Post-Test Left Side Window 6 Exterior View

Test Vehicle:	**1992 MCI MC-12 MOTOR COACH**	NHTSA No.:	**CN0800**
Test Lab:	**MGA RESEARCH CORPORATION**	Test Date:	**02/25/08**

Post-Test Left Side Window 7 Exterior View

Post-Test Front Door (Exterior)

Test Vehicle: **1992 MCI MC-12 MOTOR COACH** NHTSA No.: **CN0800**
Test Lab: **MGA RESEARCH CORPORATION** Test Date: **02/25/08**

Post-Test Right Side View of Bus

Test Vehicle:	**1992 MCI MC-12 MOTOR COACH**	NHTSA No.:	**CN0800**
Test Lab:	**MGA RESEARCH CORPORATION**	Test Date:	**02/25/08**

Post-Test Right Front ¾ View of Bus

Test Vehicle: **1992 MCI MC-12 MOTOR COACH** NHTSA No.: **CN0800**
Test Lab: **MGA RESEARCH CORPORATION** Test Date: **02/25/08**

Post-Test Right Front ¾ View of Bus (Close Up)

Test Vehicle:	**1992 MCI MC-12 MOTOR COACH**	NHTSA No.:	**CN0800**
Test Lab:	**MGA RESEARCH CORPORATION**	Test Date:	**02/25/08**

Post-Test Roof Exterior View 1

Test Vehicle:	**1992 MCI MC-12 MOTOR COACH**	NHTSA No.:	**CN0800**
Test Lab:	**MGA RESEARCH CORPORATION**	Test Date:	**02/25/08**

Post-Test Roof Exterior View 2

Test Vehicle: **1992 MCI MC-12 MOTOR COACH** NHTSA No.: **CN0800**
Test Lab: **MGA RESEARCH CORPORATION** Test Date: **02/25/08**

Post-Test Front Template Clearance View 1

Test Vehicle: **1992 MCI MC-12 MOTOR COACH** NHTSA No.: **CN0800**
Test Lab: **MGA RESEARCH CORPORATION** Test Date: **02/25/08**

Post-Test Front Template Clearance View 2

Test Vehicle:	**1992 MCI MC-12 MOTOR COACH**	NHTSA No.:	**CN0800**
Test Lab:	**MGA RESEARCH CORPORATION**	Test Date:	**02/25/08**

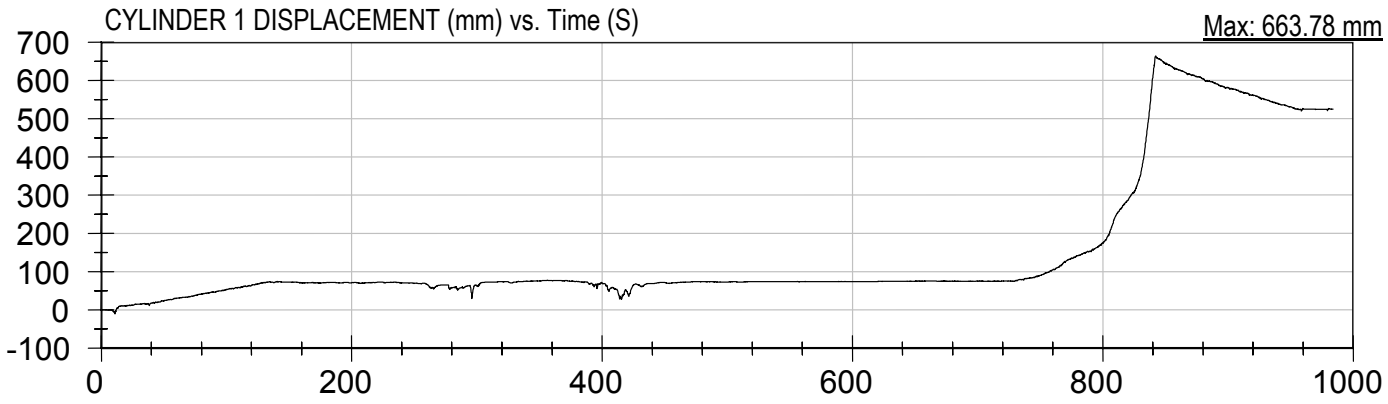
Post-Test Windshield Damage View

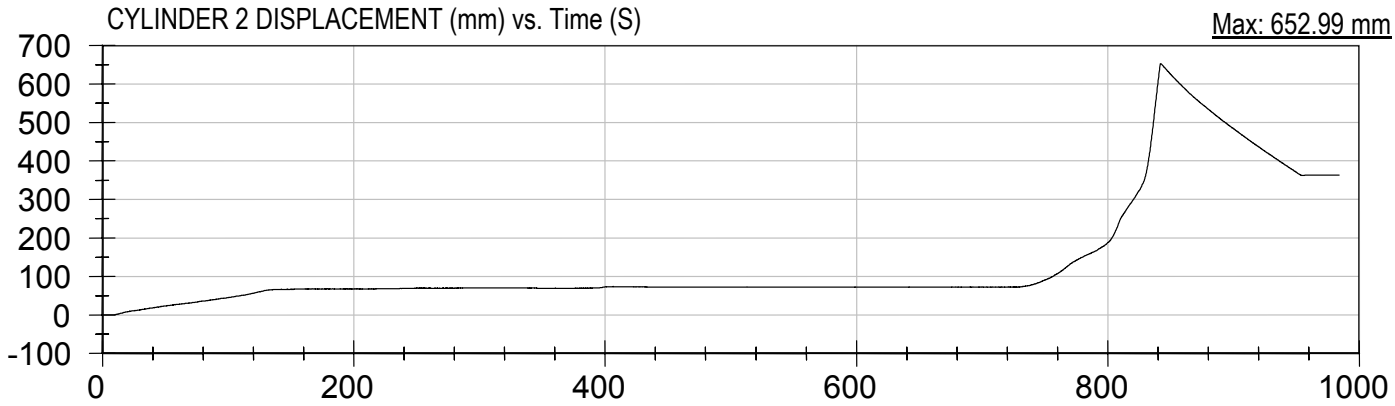
APPENDIX B
DATA PLOTS

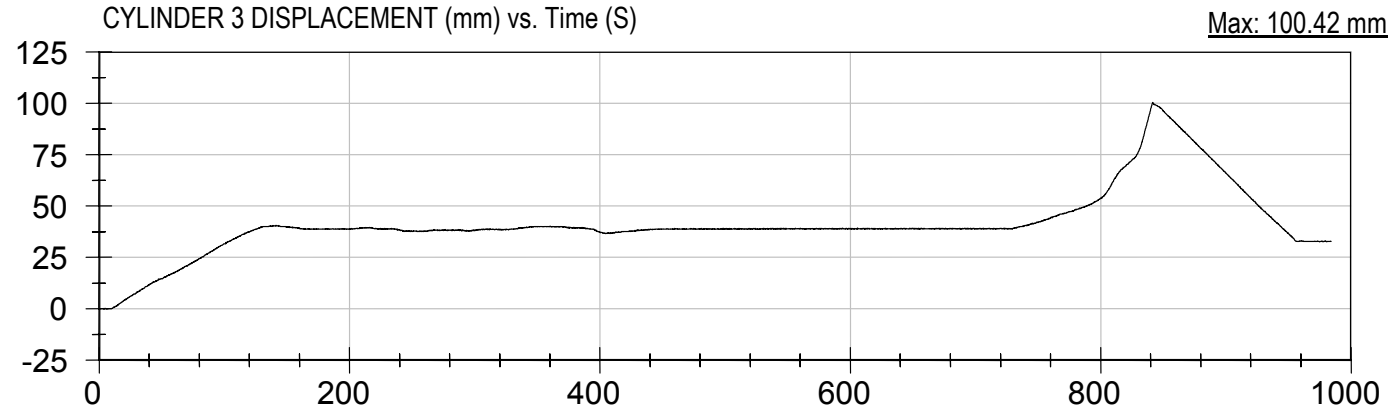
TABLE OF DATA PLOTS

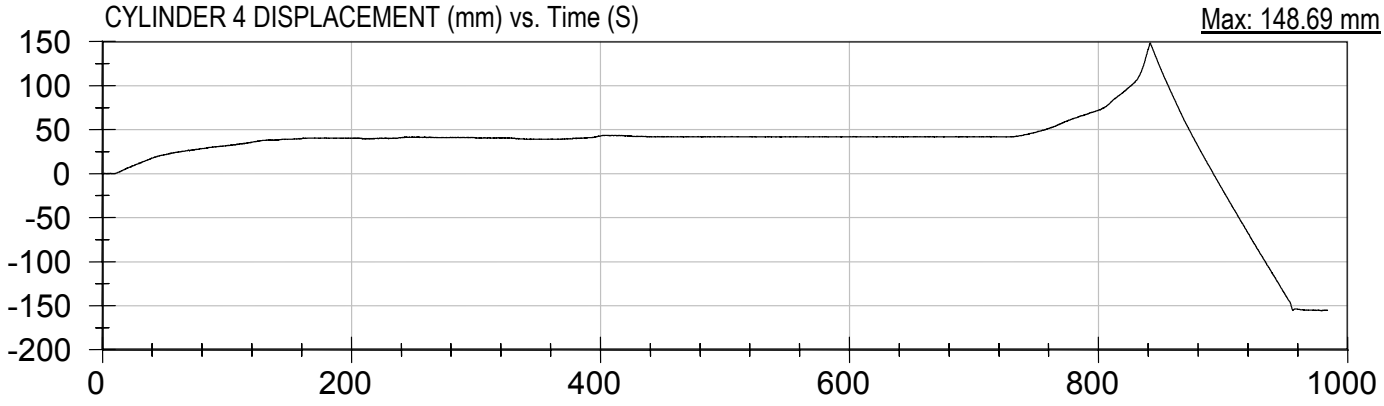
Test Description: FMVSS 220 Based Research Test
Component ID: 1992 MCI MC-12 Motor Coach

Test Date: 2/25/08



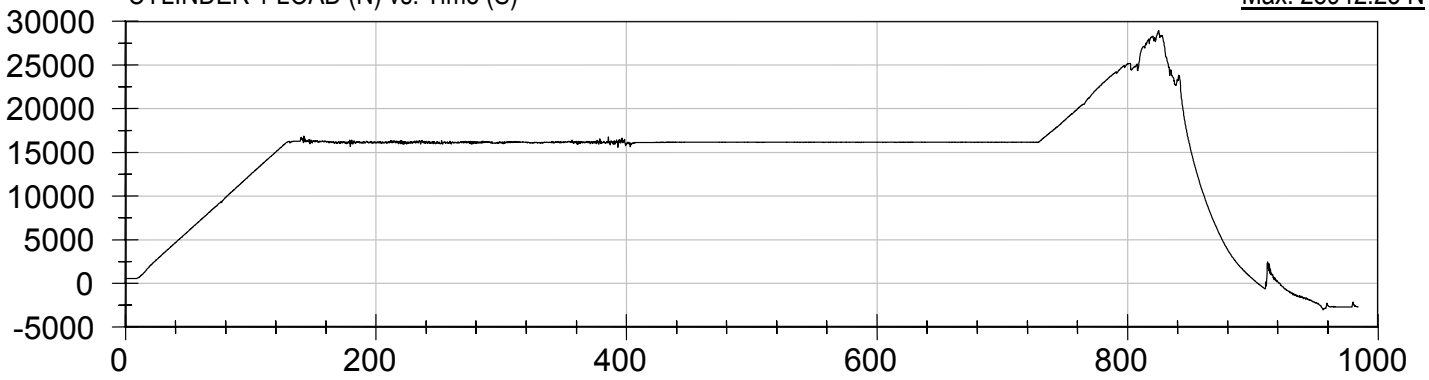






CYLINDER 1 LOAD (N) vs. Time (S)

Max: 28942.23 N



CYLINDER 2 LOAD (N) vs. Time (S)

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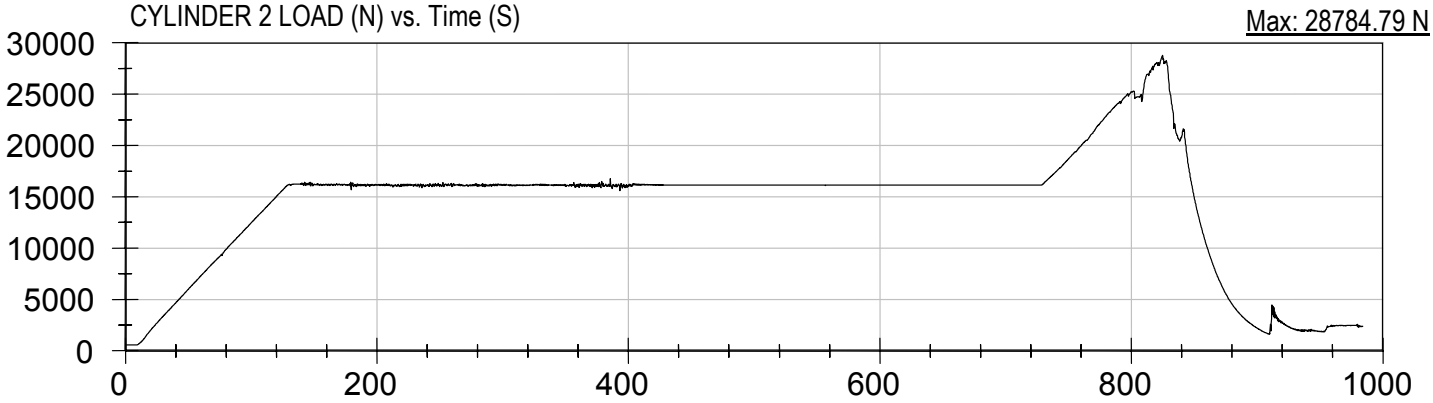
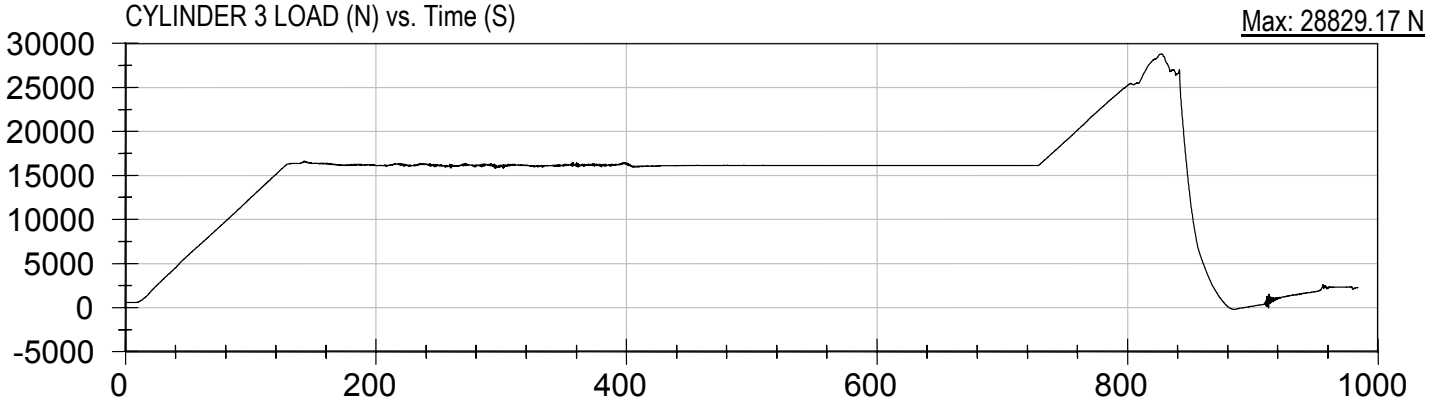


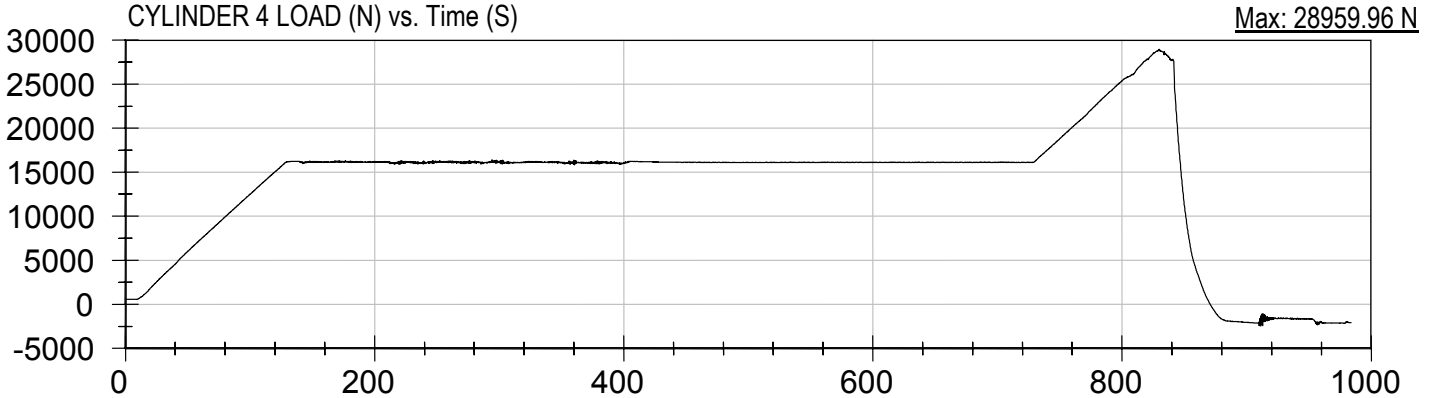
CYLINDER 3 LOAD (N) vs. Time (S)

Max: 28829.17 N



CYLINDER 4 LOAD (N) vs. Time (S)

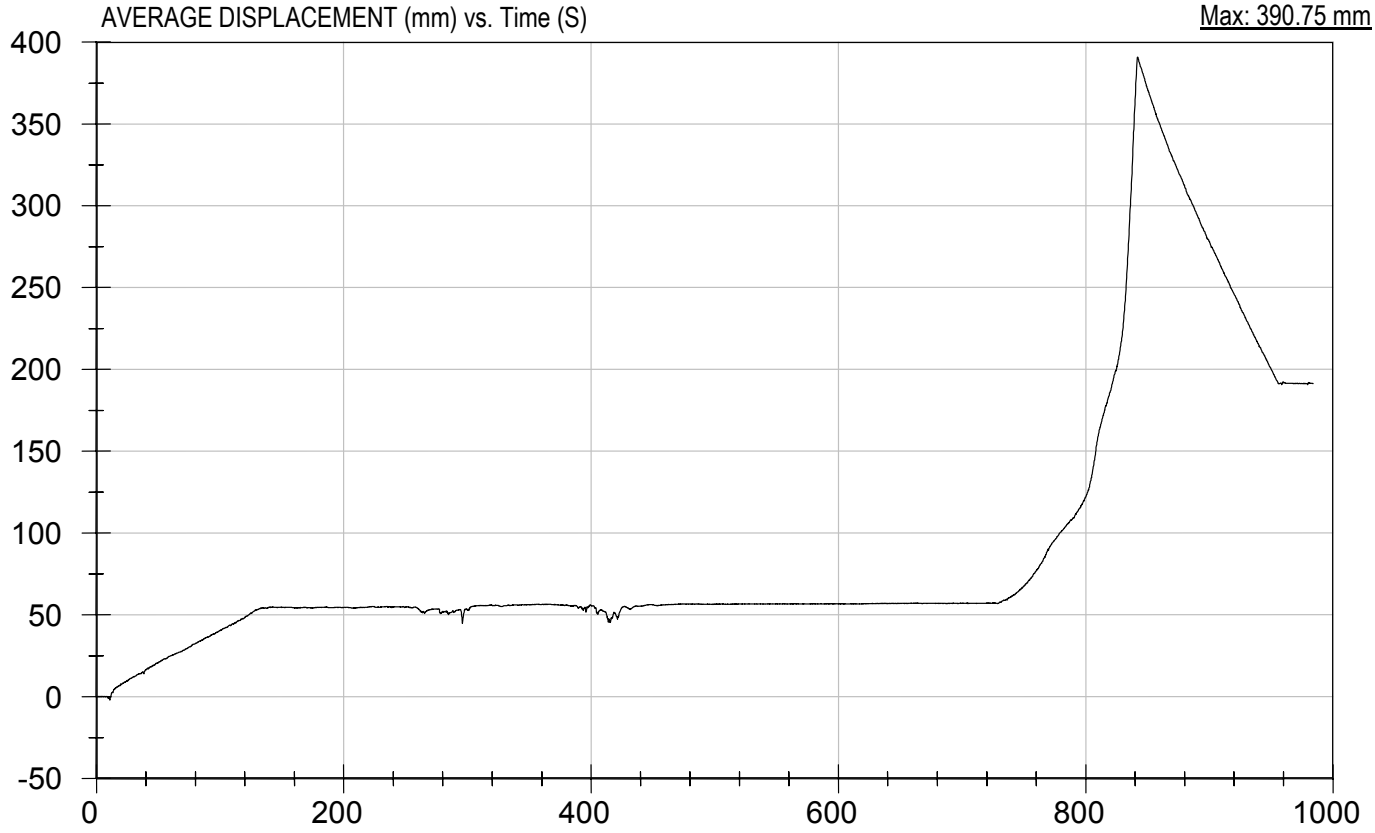
Max: 28959.96 N



Test Description: FMVSS 220 Based Research Test
Component ID: 1992 MCI MC-12 Motor Coach
Test Date: 2/25/08

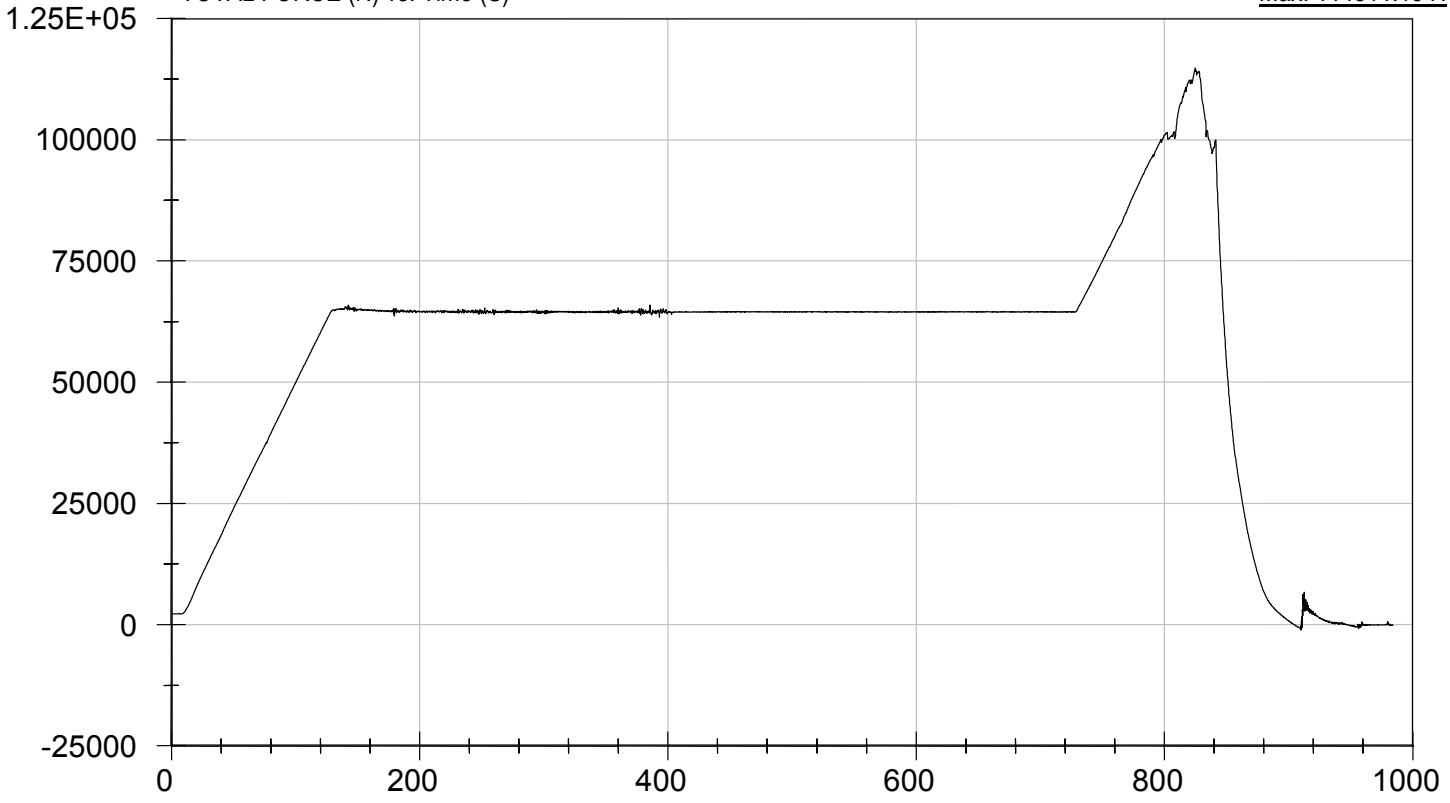
AVERAGE DISPLACEMENT (mm) vs. Time (S)

Max: 390.75 mm



TOTAL FORCE (N) vs. Time (S)

Max: 114811.15 N



APPENDIX C

INSTRUMENTATION CALIBRATION DATA

Equipment	**Description**	**Model/Serial No.**	**Cal. Date**	**Next Cal. Date**
Cylinder #1 Load Cell	Interface	1220AF/137783	09/28/07	03/28/08
Cylinder #1 Displacement Pot.	Patriot	20650	02/11/08	08/11/08
Cylinder #2 Load Cell	Interface	1220AF/137781	09/28/07	03/28/08
Cylinder #2 Displacement Pot.	Patriot	1202-19368	02/11/08	08/11/08
Cylinder #3 Load Cell	Interface	1220AF/151459	02/08/08	08/08/08
Cylinder #3 Displacement Pot.	Patriot	1102-19181	02/11/08	08/11/08
Cylinder #4 Load Cell	Interface	1220AF/138773	09/28/07	03/28/08
Cylinder #4 Displacement Pot.	Patriot	1202-19364	02/11/08	08/11/08
Force Gauge	Dillon	DFGS-R-ND / F31754	04/19/07	04/19/08
Tape Measure	Stanley Power Lock	8M / 287	10/12/07	04/12/08