

***SAFETY COMPLIANCE TESTING FOR FMVSS No. 218
MOTORCYCLE HELMETS***

Bell Helmets, Model – Zephyr
Size – M

Prepared By

Southwest Research Institute®

6220 Culebra Road

San Antonio, Texas 78238-5166

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Prepared For

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Technician: Manny R. Gonzalez
Manny R. Gonzalez

Project Manager: Daniel J. Pomeroy
Daniel J. Pomeroy

Approved By: Jenny L. Blankinship
Jenny L. Blankinship

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Accepted By: Claudia W. Covell
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16. Abstract Compliance tests were conducted on the Bell Helmets Model Zephyr motorcycle helmet in accordance with the specifications of the Office of Vehicle Safety Compliance Test Procedure No. TP-218-05. Test failures identified were as follows: None			
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SECTION 1 PURPOSE OF COMPLIANCE TEST

1 PURPOSE OF COMPLIANCE TEST

This testing was conducted as part of the Department of Transportation, National Highway Traffic Safety Administration's Federal Motor Vehicle Safety Standard (FMVSS) No. 218, "Motorcycle Helmets"¹ Compliance Program. The purpose of the test was to determine if the production helmets supplied by the Office of Vehicle Safety Compliance satisfy the requirements of TP-218-05², as governed by the contract.

2 TEST PROCEDURE

The Southwest Research Institute Test Procedure for FMVSS No. 218³ submitted to the Office of Vehicle Safety Compliance, National Highway Traffic Safety Administration, contains the specific procedures used to conduct this test. The Southwest Research Institute Test Procedure for FMVSS No. 218 as modified by project specific process travelers is in accordance with TP-218-05.

The test procedure shall not be in conflict with any portion of FMVSS No. 218 nor amendments in effect as noted in the applicable contract.

¹ National Highway Traffic Safety Administration, Federal Motor Vehicle Safety Standard (FMVSS) No. 218, "Motorcycle Helmets", 49 CFR Chapter V Section 571.218, August 20, 1973 as last amended FR 12529 on April 15, 1988.

² National Highway Traffic Safety Administration, TP-218-05, Laboratory Test Procedure for FMVSS 218 Motorcycle Helmets, February 28, 2006.

³ Southwest Research Institute, SwRI Test Procedure for Compliance Testing in Accordance with FMVSS No. 218 for Motorcycle Helmets, May 2006.

SECTION 2 COMPLIANCE TEST DATA SUMMARY

1 HELMET DATA

Helmet Brand Name: Bell Helmets
 Helmet Model Designation: Zephyr
 Helmet Manufacturer: Bell Helmets
 Helmet Size Designation: M 55-57 cm
 Helmet Coverage: Complete
 Helmet Position Index (HPI) (cm): 5.10
 Shell Material: Injection Molded Acrylonitrile Butadiene Styrene and Polycarbonate Blending Thermoplastic
 Liner Material: Expanded Polystyrene
 Buckle Description: D-Ring

Helmet	A Ambient	B Low Temp	C High Temp	D Water Immersed	E Spare
Shell Color/Pattern	Black	Black	Black	Black	Black
Weight (grams)	1556	1547	1551	1547	1565
Month & Year of Manufacture	01/2006	01/2006	10/2006	01/2006	01/2006

Comments:

The HPI and discrete helmet size were supplied by NHTSA based on information obtained from the manufacturer.

The weight was with all auxiliary equipment removed ready for testing.

Photographs of the helmets are given in Appendix C (Photographs of Equipment).

The helmet data given was based on information provided with the helmets, information provided by NHTSA, and measured data.

2 SUMMARY OF TEST RESULTS

HELMET	A Ambient	B Low Temp	C High Temp	D Water Immersed
IMPACT (S5.1, S7.1)	PASS	PASS	PASS	PASS
PENETRATION (S5.2, S7.2)	PASS	PASS	PASS	PASS
RETENTION (S5.3, S7.3)	PASS	PASS	PASS	PASS

CONFIGURATION (S5.4)	PASS
PERIPHERAL VISION/BROW OPENING (S5.4)	PASS
LABELING (S5.6)	PASS

Comments: None

3 SELECTION OF APPROPRIATE HEADFORM (S6.1)

Selection of the headform used during testing is based on the helmet size designation, marked on the helmet, as identified in the following table. If the size range is not specified on the helmet, consult with the COTR before beginning the test. As identified in FMVSS No. 218, if the helmet size designation falls into more than one of the size ranges, it shall be tested on each appropriate headform. Consult with the COTR before beginning the test.

HELMET SIZE DESIGNATION	HEADFORM SIZE	WEIGHT
$\leq 6 \frac{3}{4}$ \leq European size 54	Small	3.5, +0.00, -0.063 kg 7.8, +0.00, -0.14 lbs
$>6 \frac{3}{4}$ but $\leq 7 \frac{1}{2}$ $>$ European Size 54 but \leq European Size 60	Medium	5.0, +0.00, -0.090 kg 11.0, +0.00, -0.20 lbs
$> 7 \frac{1}{2}$ $>$ European size 60	Large	6.1, +0.00, -0.108 kg 13.4, +0.00, -0.24 lbs

Comments: A medium headform was used based on the discrete helmet size, M. The total weight of the drop assembly was 4.98 kg.

4 CONDITIONING FOR TESTING (S6.4)

The helmets shall be conditioned for not less than 12 hours in the specified environmental condition shown below, prior to testing.

IDENTIFICATION	CONDITIONS	HELMET
Ambient Conditions	21°C ± 6°C, 40% to 60% RH, Site Pressure 59°F to 81°F	A
Low Temperature	-10°C +8°C, -0°C 14°F to 28°F	B
High Temperature	50°C +0°C, -4°C 115°F to 122°F	C
Water Immersion	25°C ± 6°C 66°F to 88°F	D

The maximum time during which the helmet may be out of the conditioning environment shall not exceed 4 minutes. It must then be returned to the conditioning environment for a minimum of 3 minutes for each minute or portion of a minute in excess of 4 minutes out of the conditioning environment or 12 hours, whichever is less, prior to resumption of testing.

The first test shall be performed at a time greater than 2 minutes after removal from conditioning. The second test in a sequence shall be performed before the 4-minute limit.

The helmets were conditioned prior to testing. Records of the conditioning are given in Section 3.1 (Conditioning Environments).

Comments: None.

5 IMPACT TESTING (S5.1 & S7.1)

The helmets were subjected to the impact attenuation testing in accordance with the requirements of S5.1 and S7.1 of FMVSS No. 218.

Bell Helmets, Zephyr, M
Impact Testing

Anvil	Impact Velocity
Hemispherical	4.8 to 5.2 m/sec
Flat	5.6 to 6.0 m/sec

Temperature C	Relative Humidity %
20	55

Headform Size = Medium
Impact Position on Crown

Drop Assembly Weight = 4.98 kg

System Check	Drop No	Drop Height (cm)	Vel (m/sec)	Peak Acceleration (g)	Dwell Time (msec)	
					at 150 g's	at 200 g's
Pre Test	1A	124	4.89	400	2.12	1.82
	2A	124	4.82	396	2.12	1.84
	3A	124	4.89	398	2.12	1.82
Pre Test Average		---	---	398	---	---
Post Test	1B	124	4.89	399	2.12	1.82
	2B	124	4.82	398	2.12	1.84
	3B	124	4.96	399	2.10	1.84
Post Test Average		---	---	399	---	---
Difference Between Pre Test and Post Test Averages				1	Difference Not to Exceed 40 g's	

Bell Helmets, Zephyr, M
Impact Testing

Helmet Designation	Helmet Condition	Helmet Type	Impact Location (+/- 45 degrees)							
		Partial/Full	Forehead		Left Side		Right Side		Rear	
		Complete	Left Front		Right Rear		Right Front		Left Rear	
		Impact No.	1	2	1	2	1	2	1	2
A	Ambient	Anvil	Hemi		Hemi		Flat		Flat	
		Test Record No.	3	4	11	12	19	20	27	28
		Peak g	88	105	112	129	158	166	177	198
		ms @ 150 g	0.00	0.00	0.00	0.00	0.56	1.84	2.54	2.74
		ms @ 200 g	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Velocity m/sec	5.20	5.20	5.20	5.19	6.04	5.92	5.93	5.94
B	Low Temperature	Anvil	Hemi		Hemi		Flat		Flat	
		Test Record No.	5	6	13	14	21	22	29	30
		Peak g	96	109	114	140	163	171	182	197
		ms @ 150 g	0.00	0.00	0.00	0.00	1.10	2.14	2.50	2.74
		ms @ 200 g	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Velocity m/sec	5.27	5.19	5.19	5.20	5.94	5.94	6.04	5.93
C	High Temperature	Anvil	Hemi		Hemi		Flat		Flat	
		Test Record No.	7	8	15	16	23	24	31	32
		Peak g	82	98	98	114	147	159	170	198
		ms @ 150 g	0.00	0.00	0.00	0.00	0.00	1.30	2.22	2.80
		ms @ 200 g	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Velocity m/sec	5.20	5.21	5.20	5.19	5.92	6.04	5.93	6.03
D	Water Immersed	Anvil	Hemi		Hemi		Flat		Flat	
		Test Record No.	9	10	17	18	25	26	33	34
		Peak g	85	93	104	134	139	173	185	193
		ms @ 150 g	0.00	0.00	0.00	0.00	0.00	2.14	2.56	2.66
		ms @ 200 g	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Velocity m/sec	5.21	5.19	5.11	5.11	5.93	5.92	6.02	5.93

Comments: The helmet passed the impact testing.

Recorded by: Manny Gonzalez

Approved by: Daniel Pomerening

August 10, 2006

6 PENETRATION (S5.2 & S7.2)

The helmets were subjected to the penetration test in accordance with the requirements of S5.2 and S7.2 of FMVSS No. 218.

Weight of Striker: 3, +0.000, -0.029 kg
6.625, +0.000, -0.065 lbs

Point of Striker: Included angle of 60°, +1.0°, -0.0°
Cone height of 3.8, +0.25, -0.00 cm (1.5, +0.1, -0.0 inches)
Radius of 0.5, +0.08, -0.0 mm (0.19, +0.003, -0.000 inches)
Minimum hardness of 60 Rockwell (Scale C)

The height of the free fall drop was 300, +0.00, -3.05 cm (118.1, +0.0, -1.2 inches) as measured from the striker point to the impact point on the outer surface of the test helmet. Two penetration blows are applied to each helmet at least 7.6 cm (3 inches) apart and at least 7.6 cm (3 inches) from the centers of any impacts applied during the impact attenuation test.

When tested, the test helmet shall be failed if the striker has made an indentation in the headform.

AMBIENT TEMPERATURE °C	AMBIENT RELATIVE HUMIDITY %
20	54

TEST	HELMET	CONDITION	PASS	FAIL
1	A	Ambient	PASS	
2	A	Ambient	PASS	
3	B	Low Temperature	PASS	
4	B	Low Temperature	PASS	
5	C	High Temperature	PASS	
6	C	High Temperature	PASS	
7	D	Water Immersed	PASS	
8	D	Water Immersed	PASS	

Comments: This helmet passed the penetration testing. The free fall drop was 298.5 cm.

7 RETENTION SYSTEM TESTING (S5.3 & S7.3)

The helmets were subjected to the retention system testing in accordance with the requirements of S5.3 and S7.3 of FMVSS No. 218.

READING	APPLIED LOAD
INITIAL	22.7, +4.54, -0.0 kg 50, +10, -0 lbs.
FINAL	136, +0.0, -4.5 kg 300, +0.0, -10.0 lbs

AMBIENT TEMPERATURE °C	AMBIENT RELATIVE HUMIDITY %
20	54

The acceptance criteria shall be that the retention system remained intact without elongating more than 2.54 cm (1 inch).

HELMET	CONDITIONS	INITIAL READING (cm)	FINAL READING (cm)	ELONGATION (cm)
A	Ambient	0.00	1.90	1.90
B	Low Temperature	0.00	1.81	1.81
C	High Temperature	0.00	2.24	2.24
D	Water Immersed	0.00	2.01	2.01

Time histories for the retention system testing are given in Section 3.3 Retention Time Histories. Given on these plots are the conditioning environment, load, and elongation.

Comments: This helmet passed the retention testing.

8 PERIPHERAL VISION AND BROW OPENING (S5.4)

The helmet shall provide a minimum peripheral vision of 105° to each side of the mid-sagittal plane through the basic plane. The brow opening shall be at least 2.54 cm (1 inch) above all points in the basic plane that are within the angles of peripheral vision.

	REQUIREMENTS	TEST RESULTS
PERIPHERAL VISION	> 105°	> 105 °
BROW OPENING	> 2.54 cm	> 2.54 cm

Comments: This helmet passed the peripheral vision and brow opening testing.

9 CONFIGURATION (S5.4)

The configuration of this helmet must be such that it has a protective surface of continuous contour at all points above the test line.

Comments: The helmet passed the configuration requirements.

10 PROJECTIONS (S5.5)

A helmet shall not have any internal rigid projections. External rigid projections shall be limited to those required for operation of essential accessories, and shall not protrude more than 5mm (0.20 inches).

PROJECTION	REQUIREMENT
INTERNAL RIGID	None
EXTERNAL RIGID	Operational, shall not protrude more than 5 mm (0.20 inches)

Test Results

PROJECTION	PRESENT	HEIGHT (mm)
INTERNAL	No	NA
EXTERNAL	Yes	5.0

Comments: External projections include plastic vent covers that are located above the test line.

11 LABELING (S5.6)

Each helmet shall be permanently and legibly labeled, in a manner such that the label(s) can be easily read without removing padding or any other permanent part. The following information shall be included:

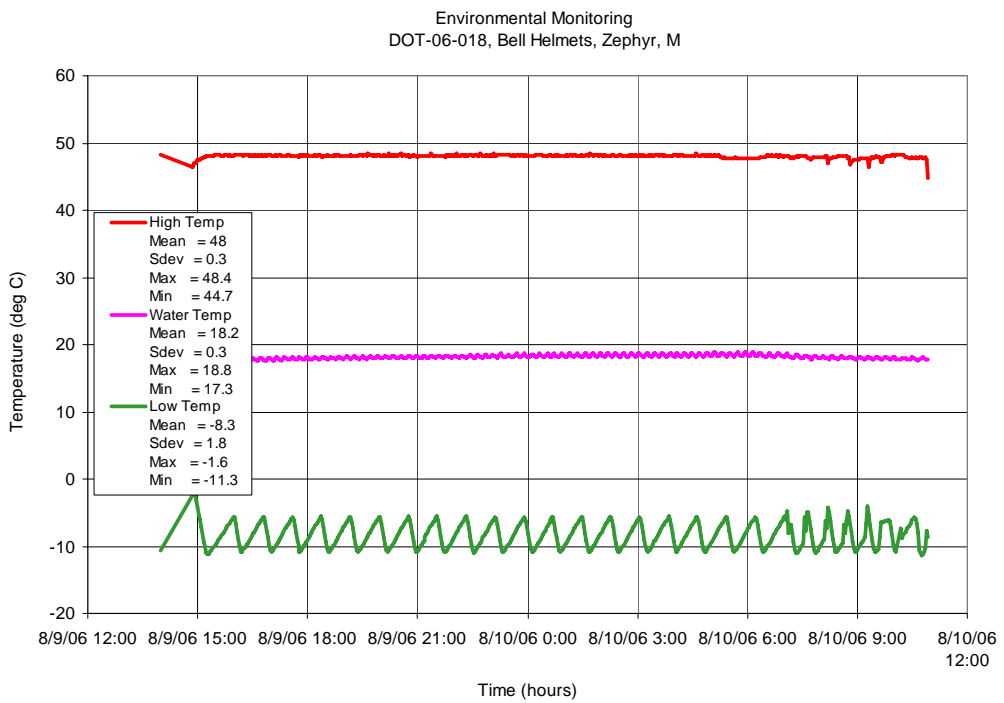
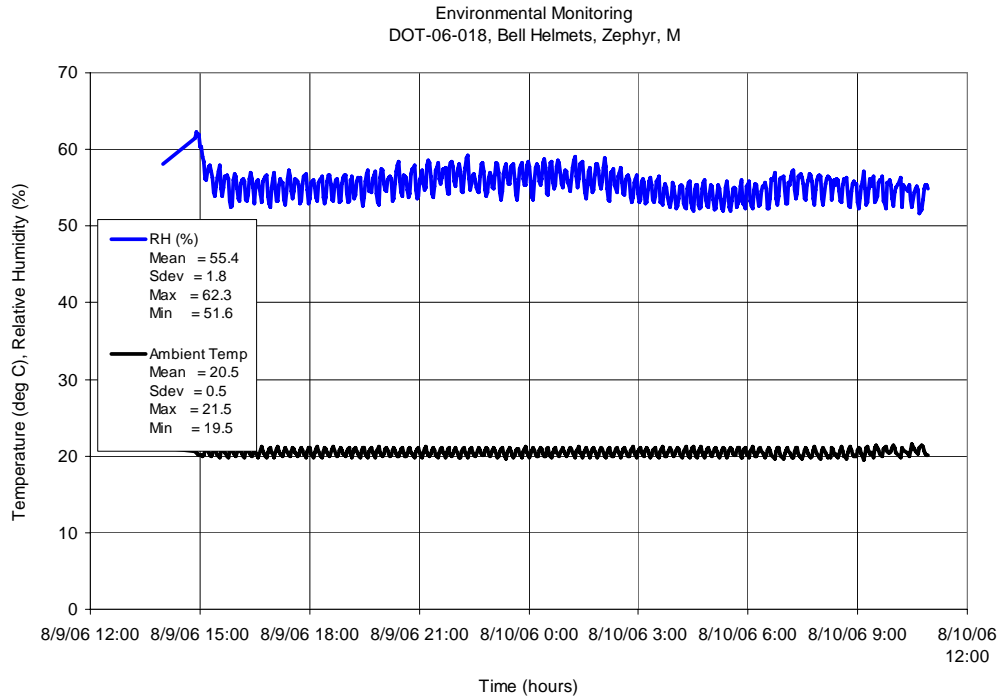
REQUIRED INFORMATION	PASS	FAIL
(1) Manufacturer's name or identification.	PASS	
(2) Precise model designation.	PASS	
(3) Size.	PASS	
(4) Month and year of manufacture.	PASS	
(5) The DOT symbol, constituting the manufacturer's certification that the helmet conforms to the applicable Federal Motor Vehicle Safety Standards. This symbol shall appear on the outer surface, in a color that contrasts with the background, in letters at least 1 cm (0.375 inch) high centered laterally with the horizontal centerline on the symbol located a minimum of 2.9 cm (1.125 inches) and a maximum of 3.5 cm (1.375 inches) from the bottom edge of the posterior portion of the helmet.	PASS	
(6) Instruction to the Purchaser as follows:		
Shell and liner constructed of (identify type(s) of materials)	PASS	
The helmet can be seriously damaged by some common substances without the damage being visible to the user.	PASS	
Apply only the following: (Recommended cleaning agents, paints, adhesives, etc. as appropriate).	PASS	
Make no modifications.	PASS	
Fasten helmet securely.	PASS	
If the helmet experiences a severe blow, return it to the manufacturer for inspection or destroy and replace it.	PASS	

Comments: None

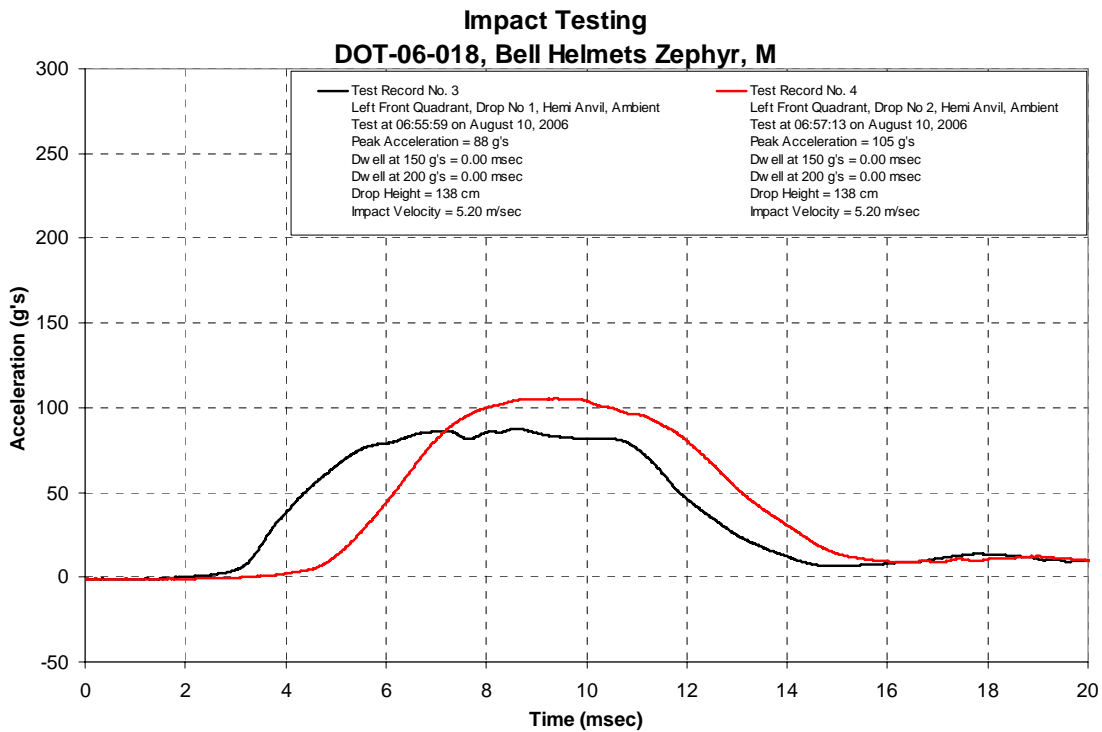
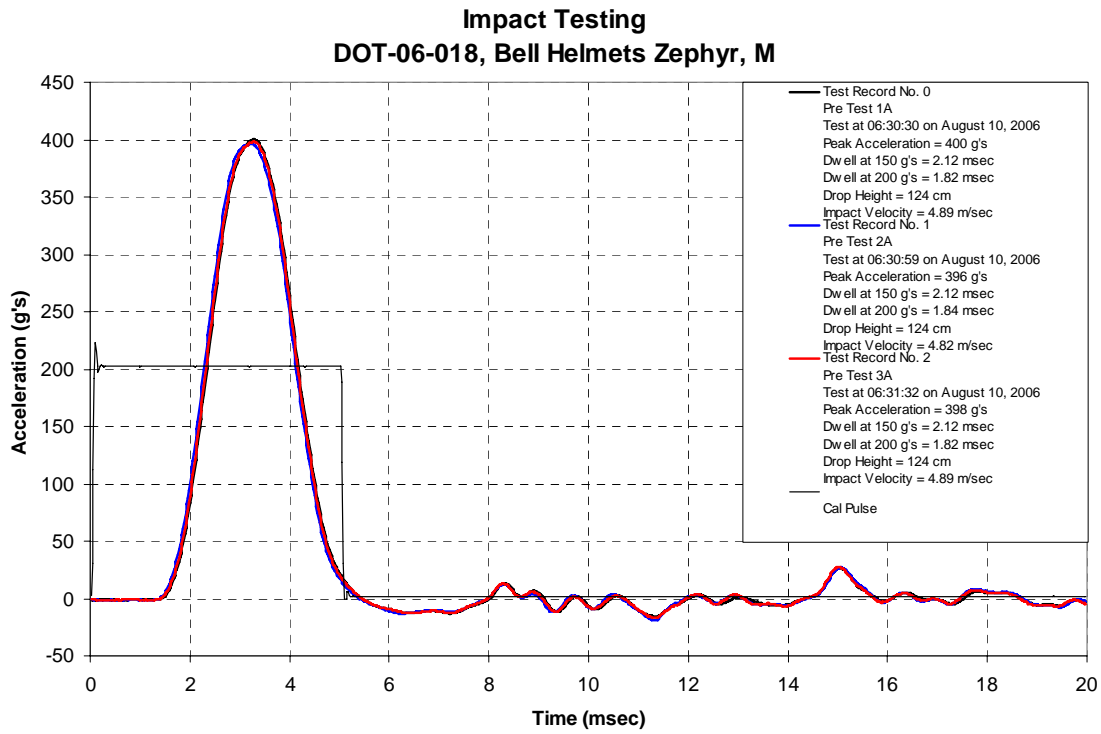
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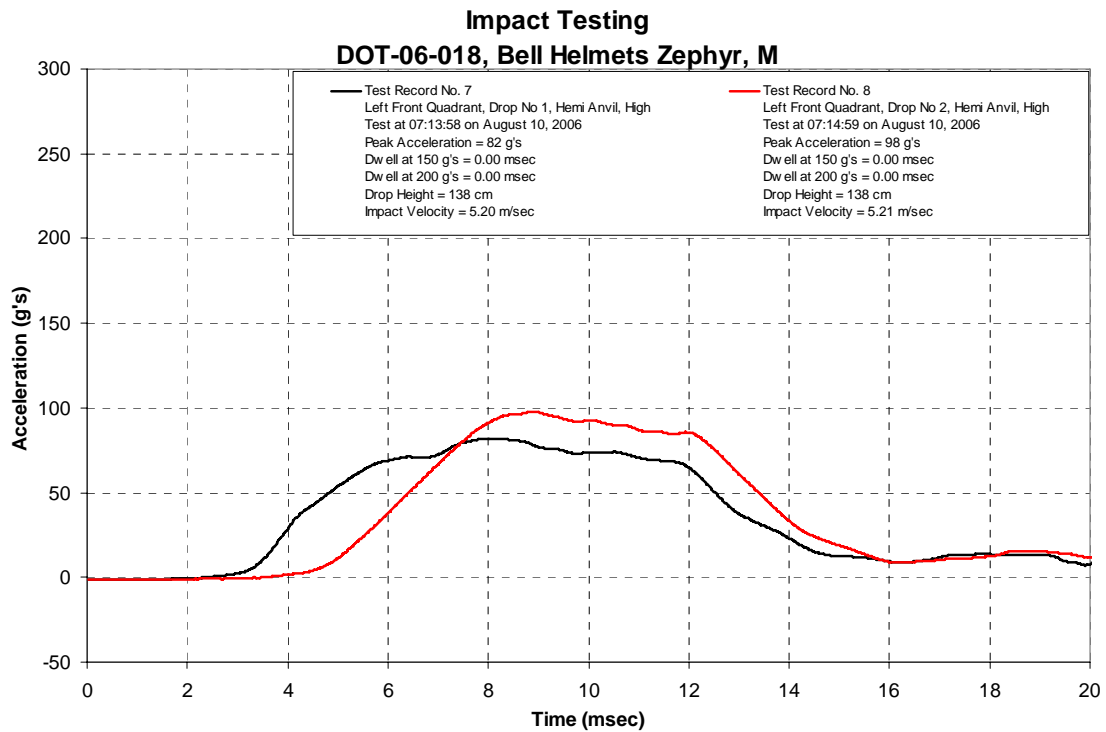
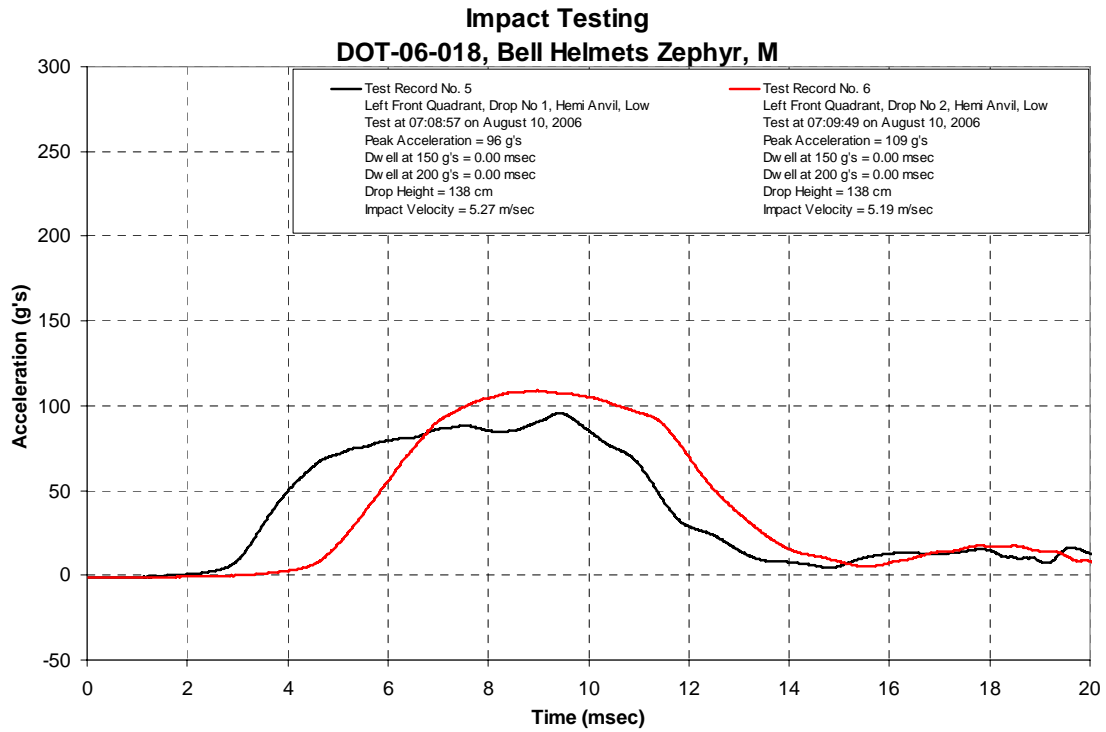
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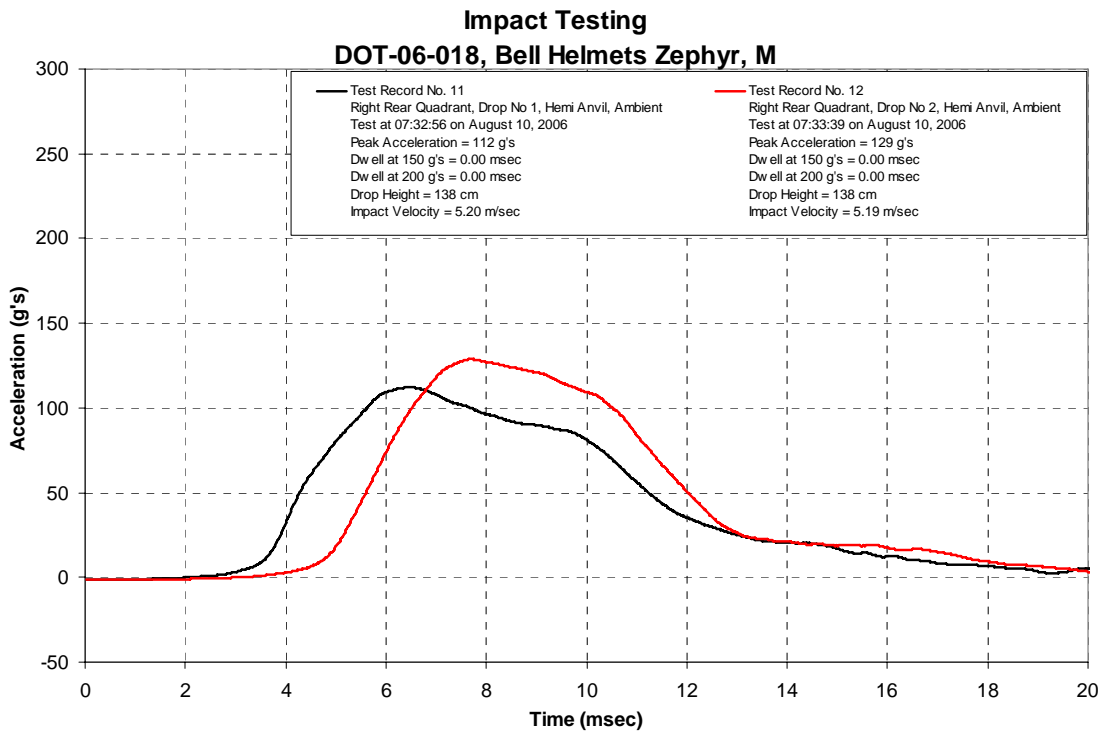
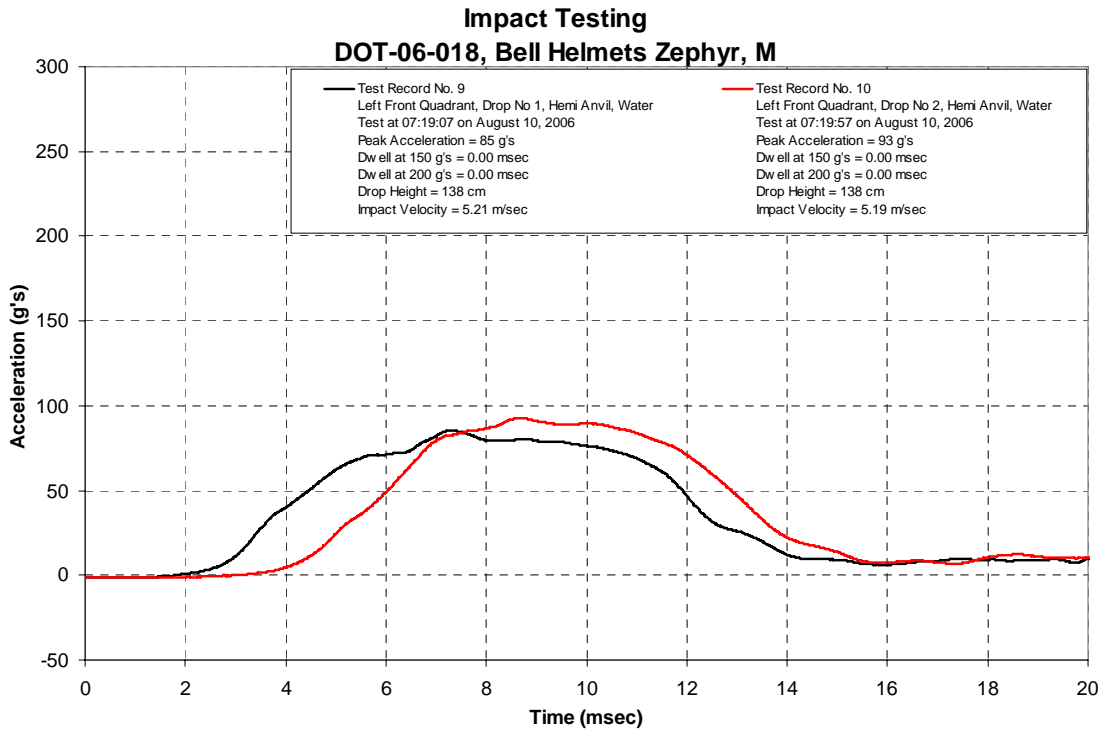
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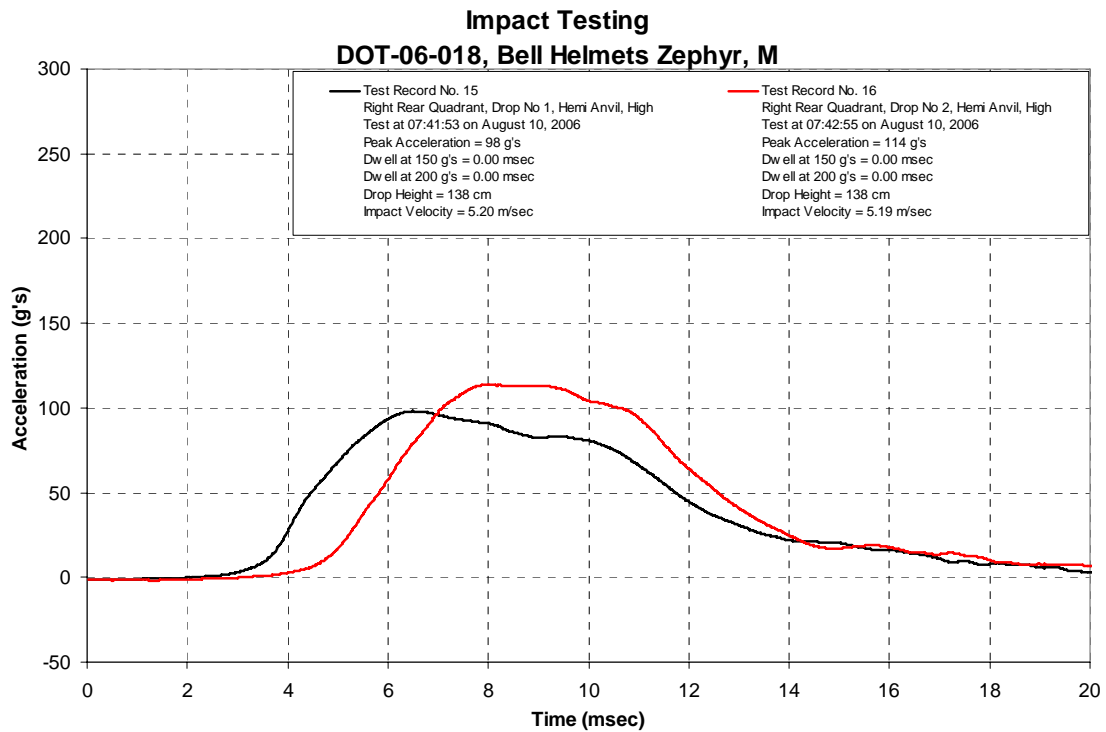
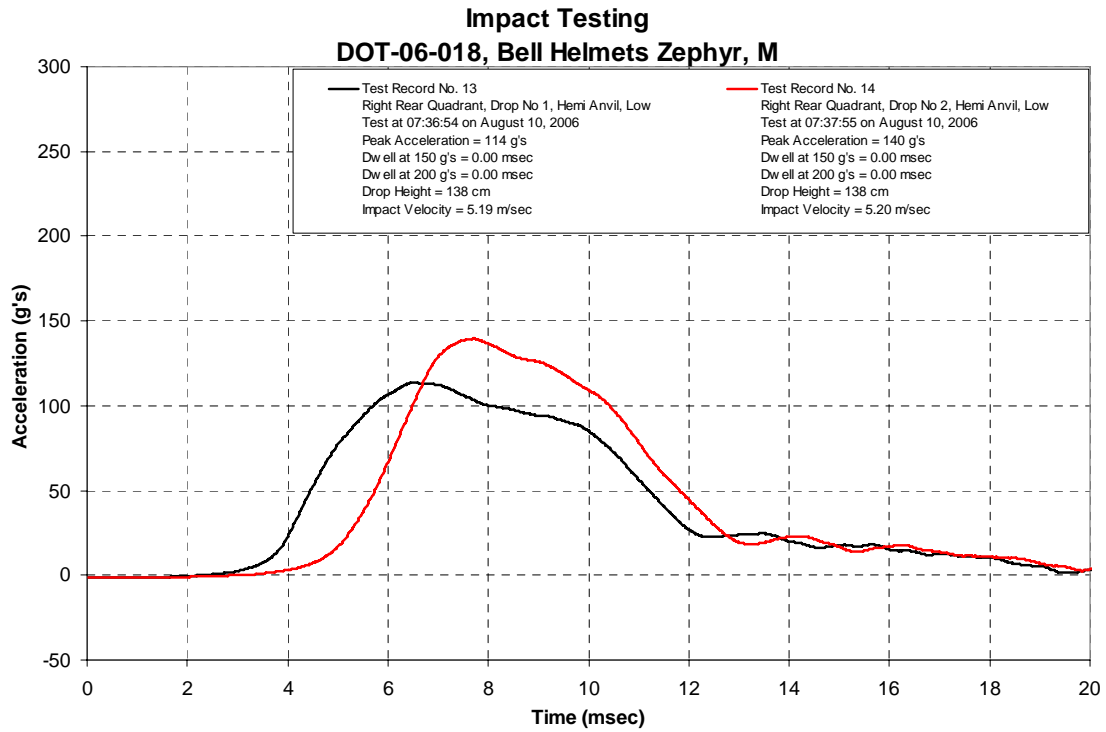


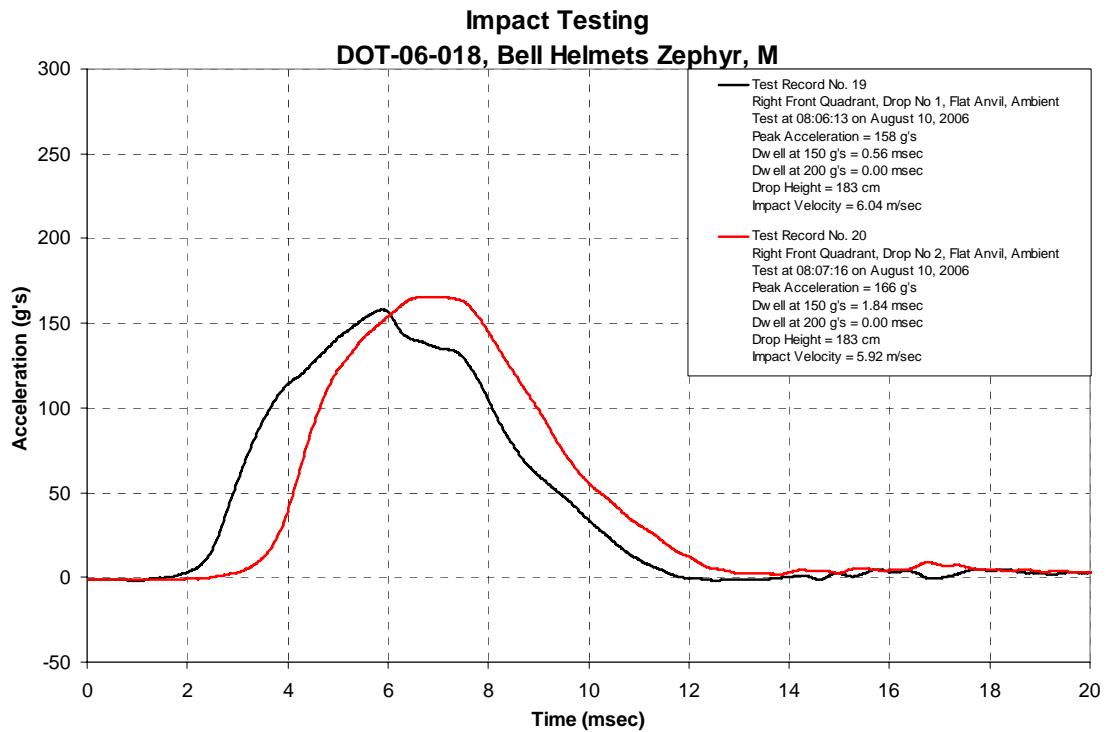
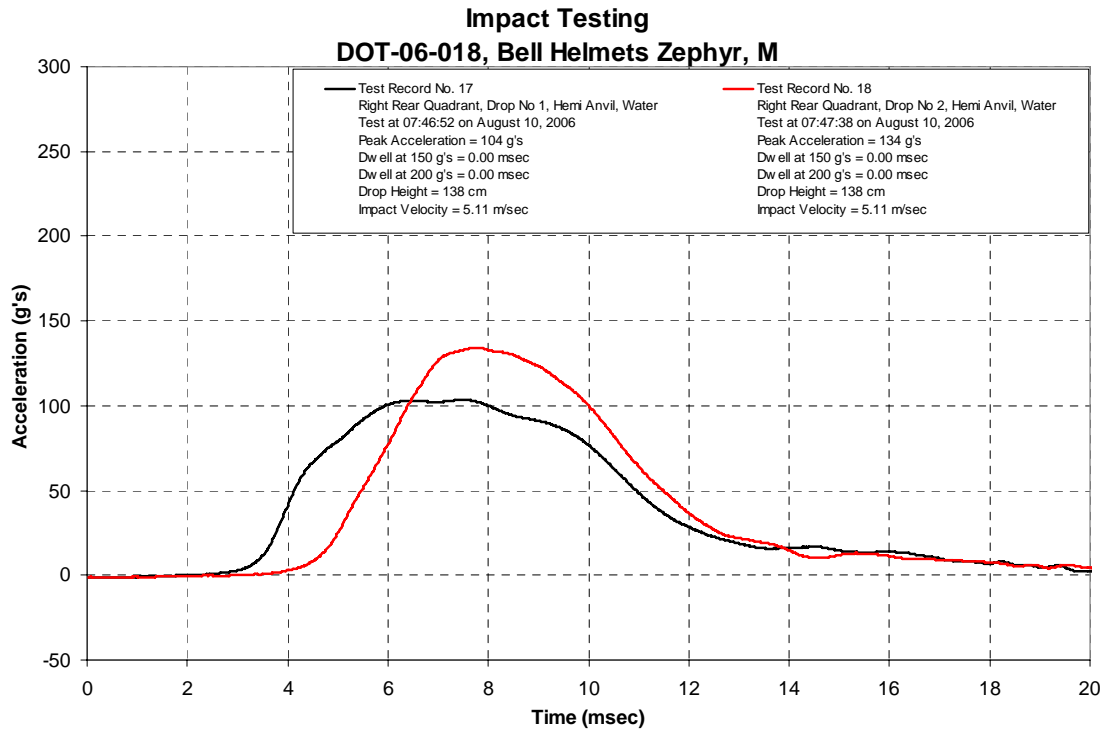
2 IMPACT TIME HISTORIES

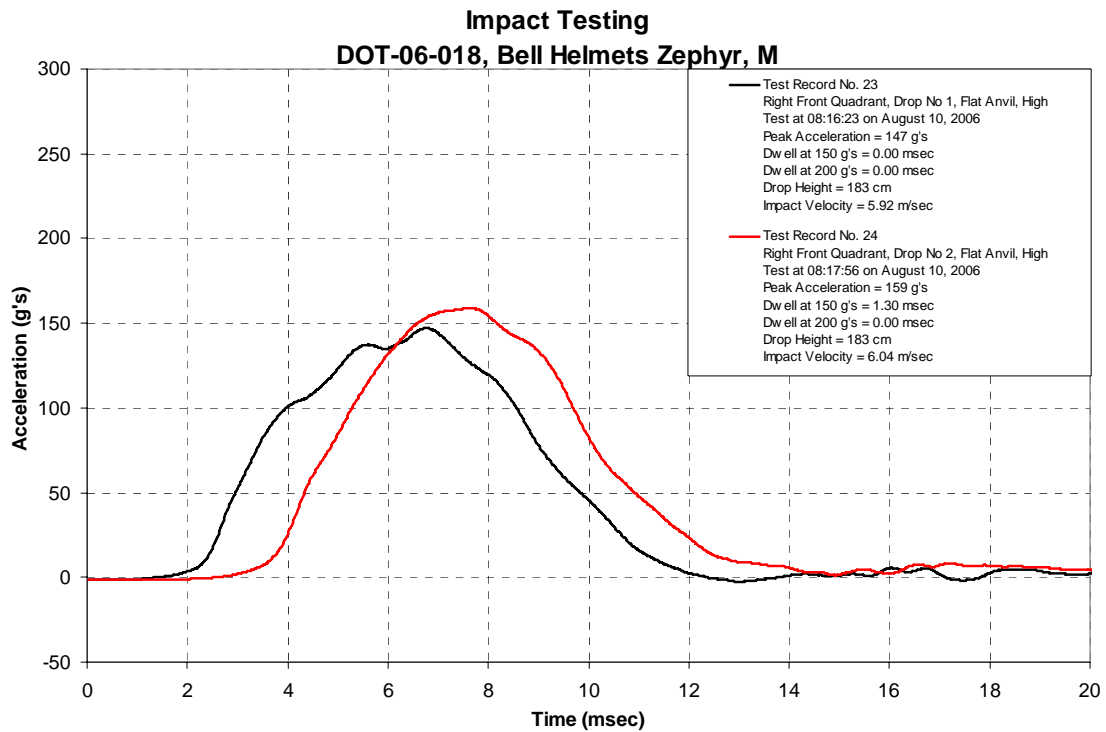
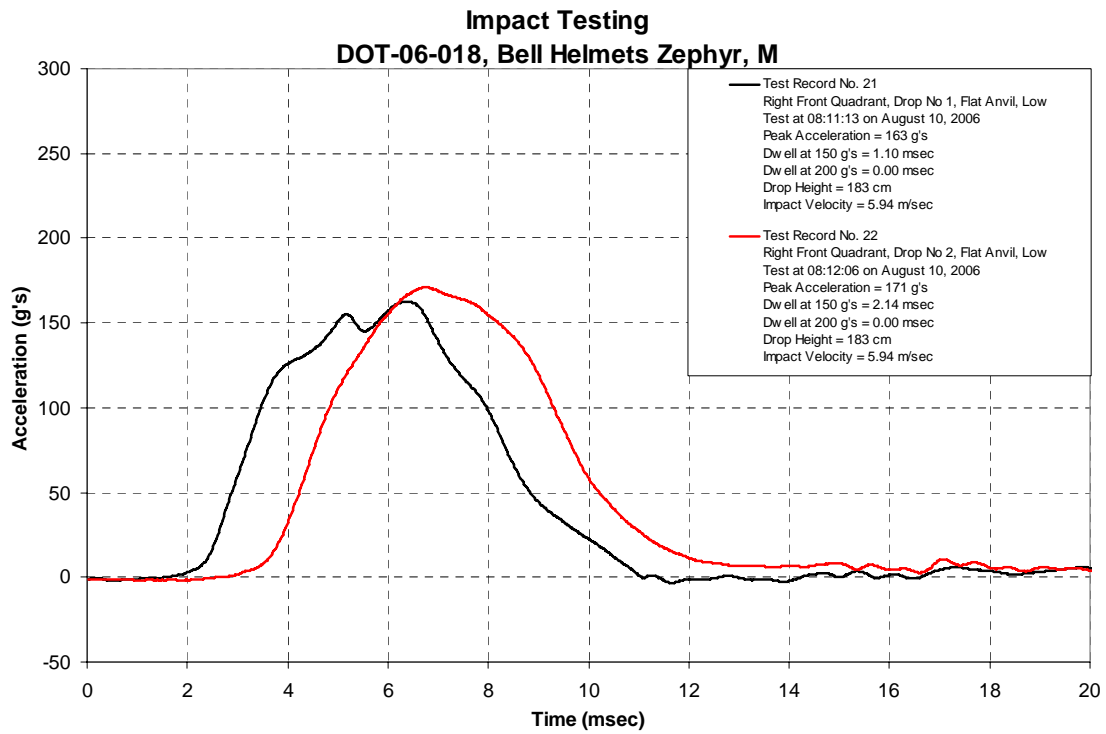


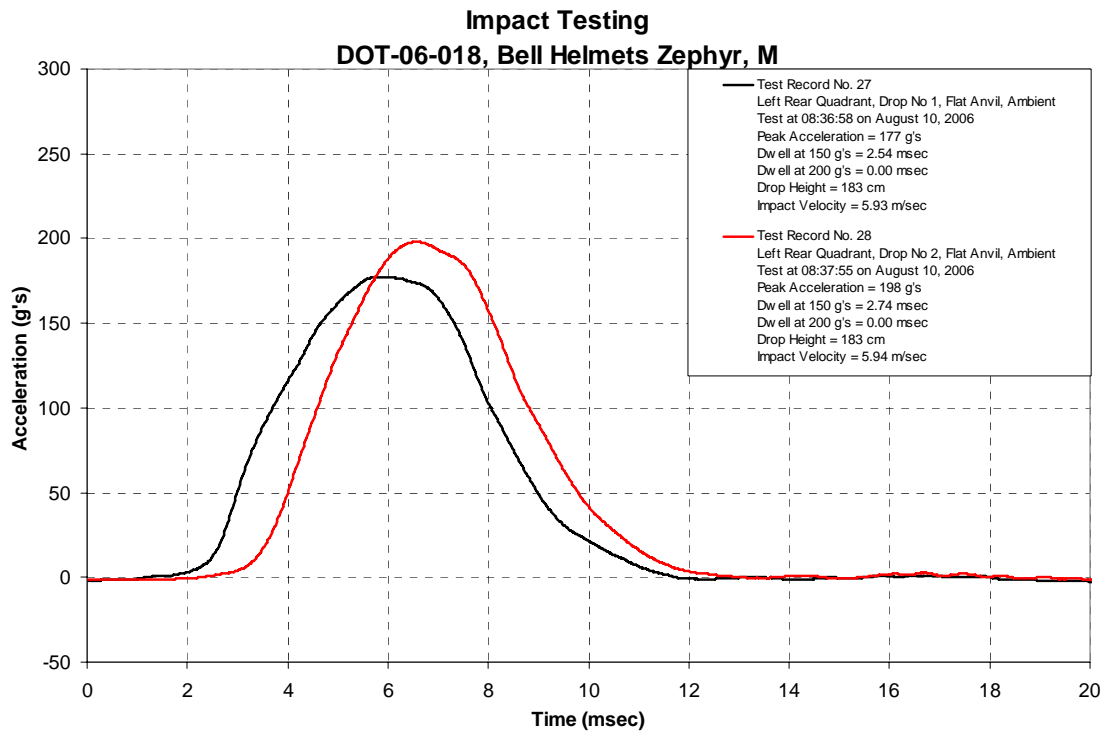
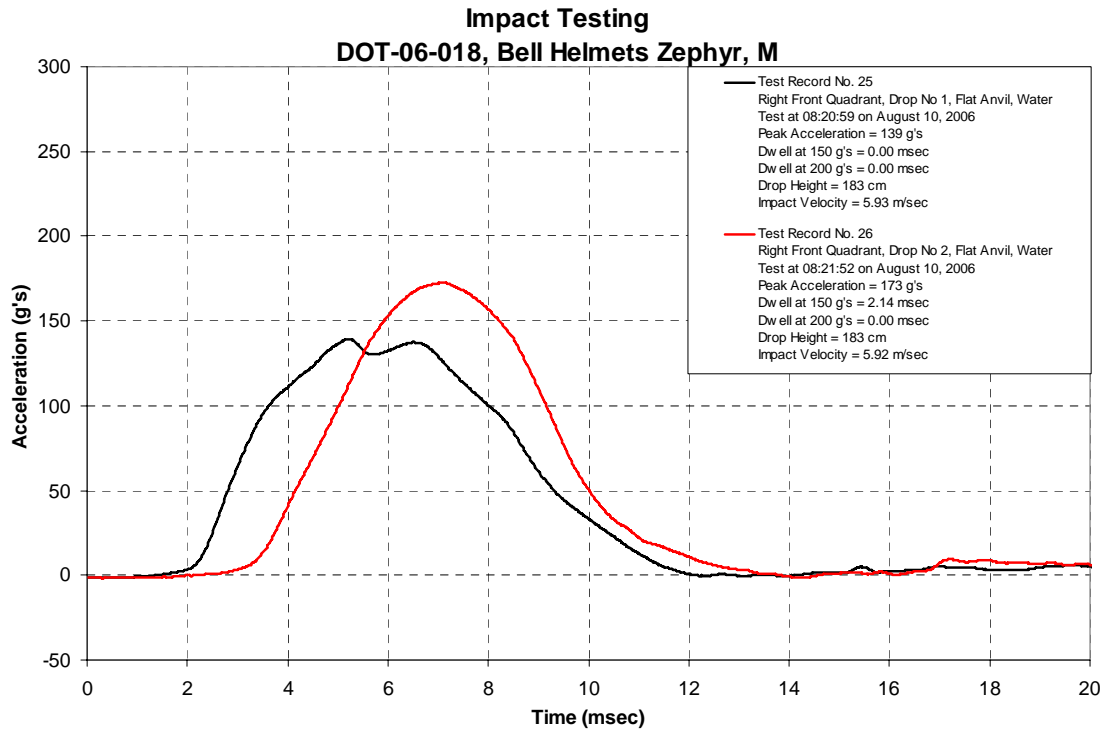


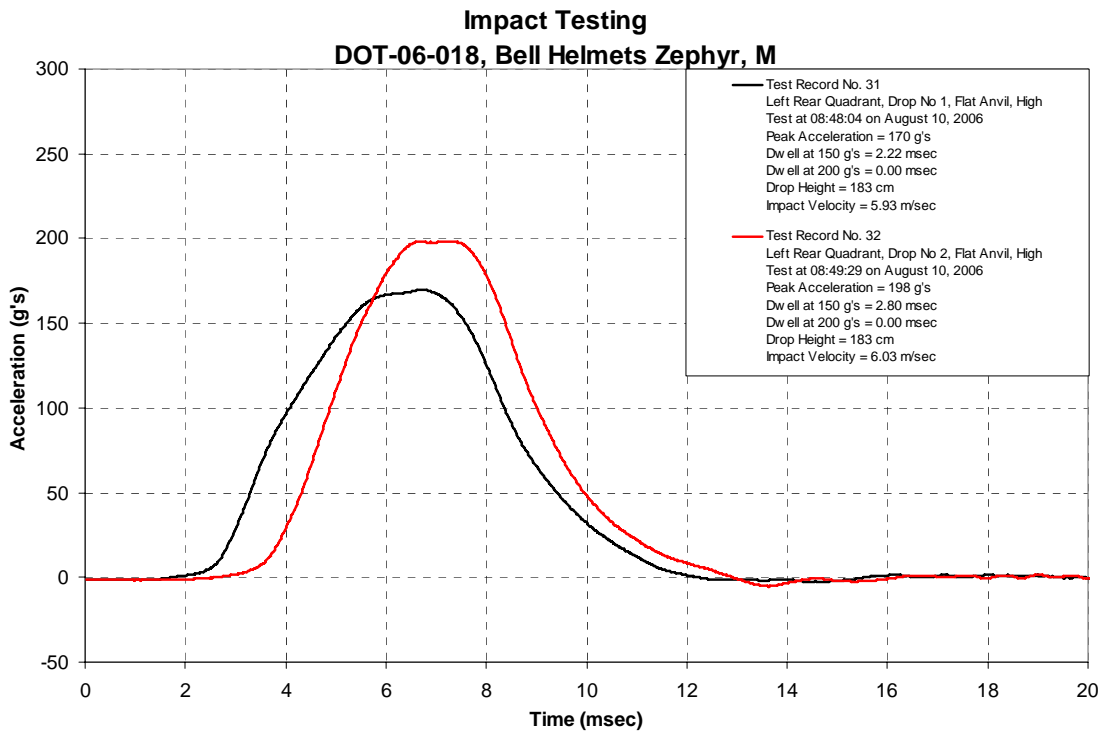
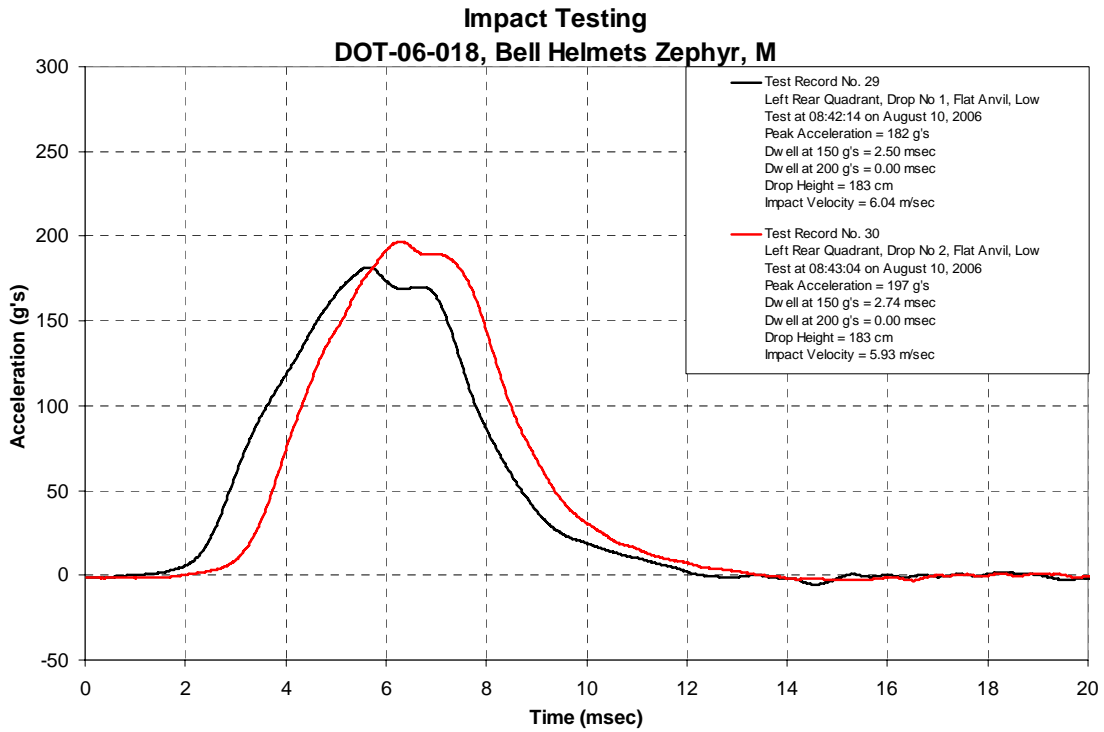


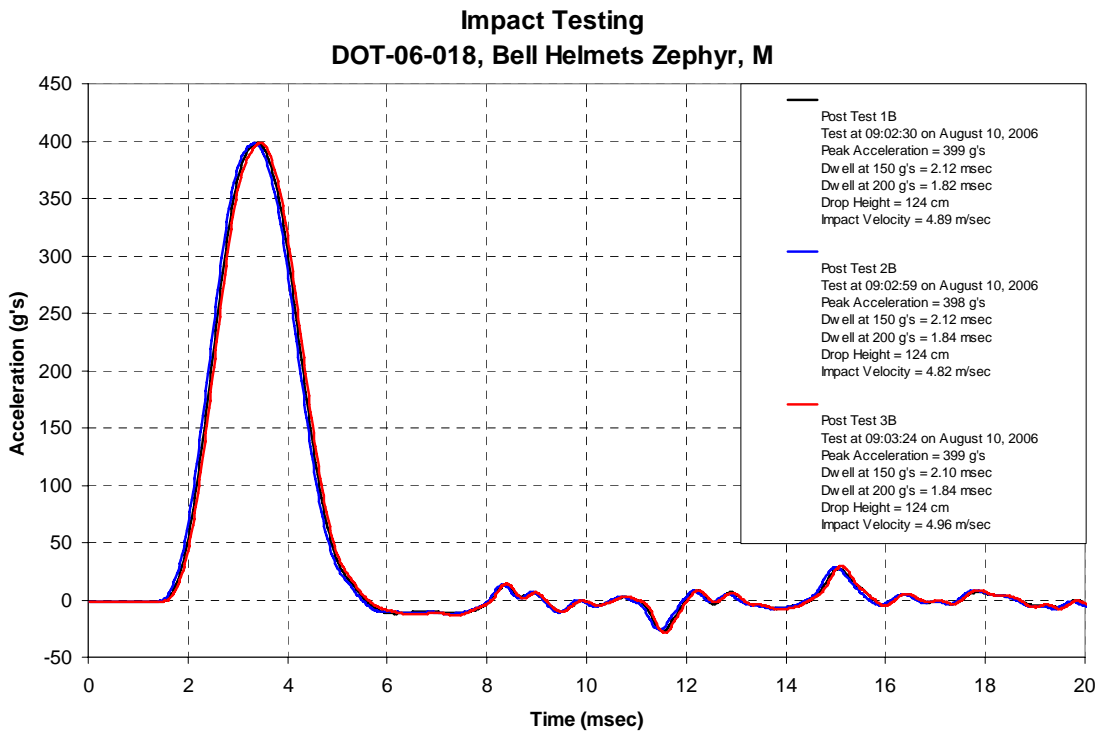
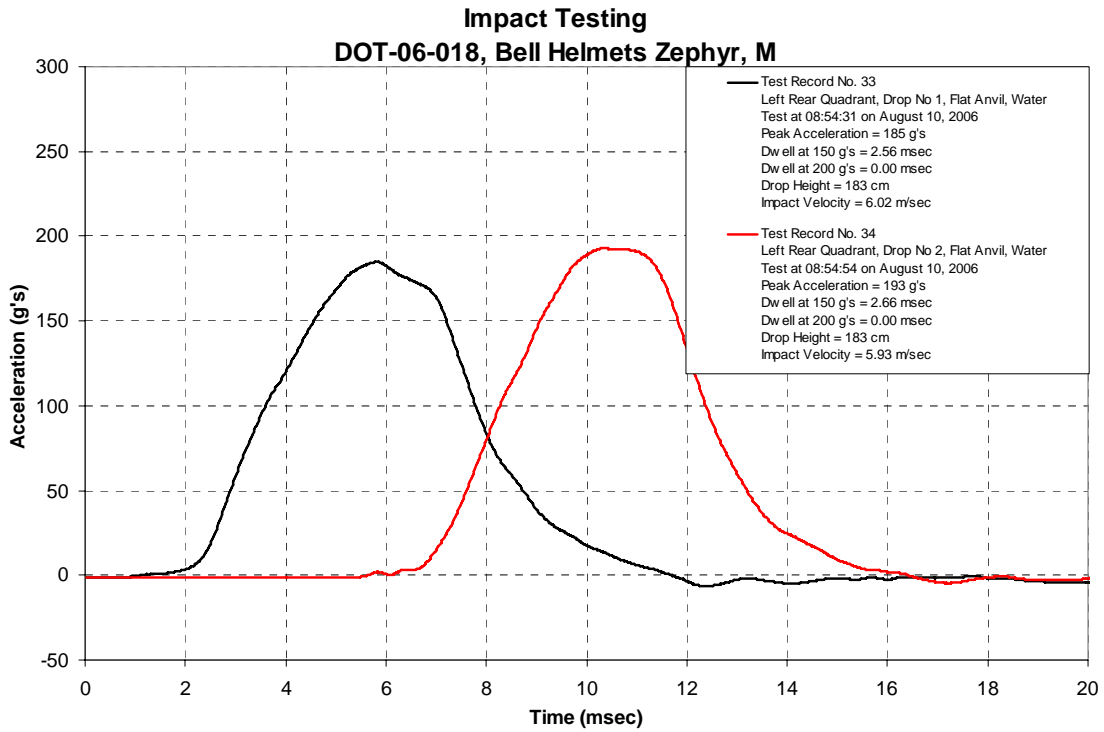




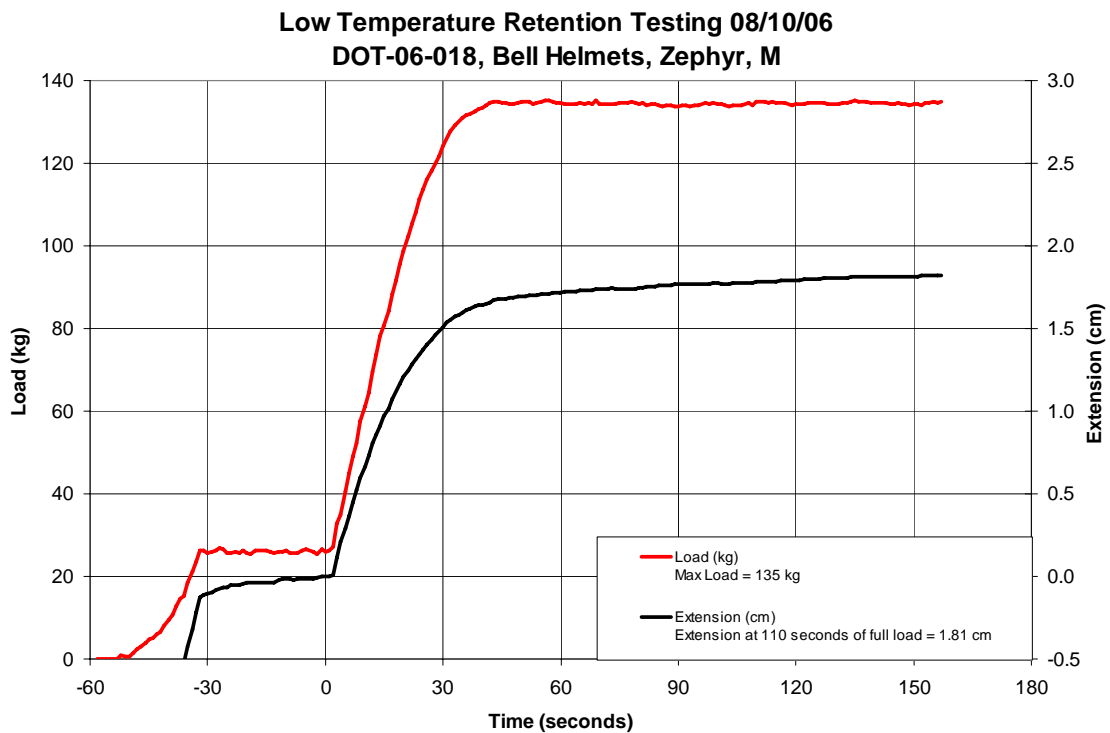
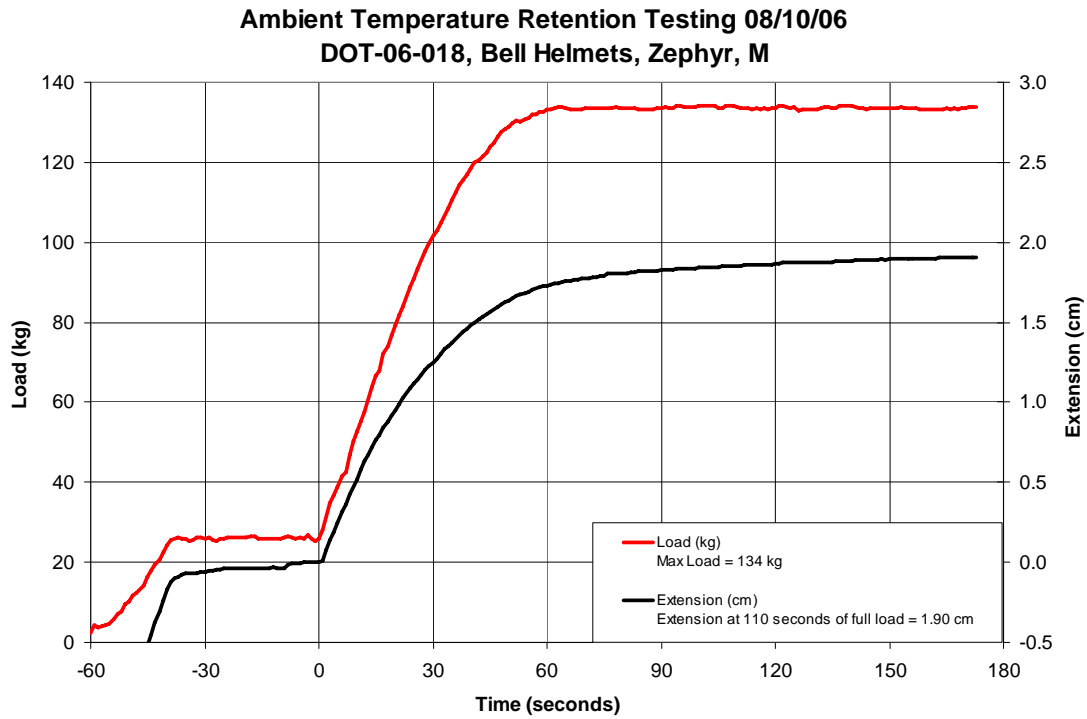




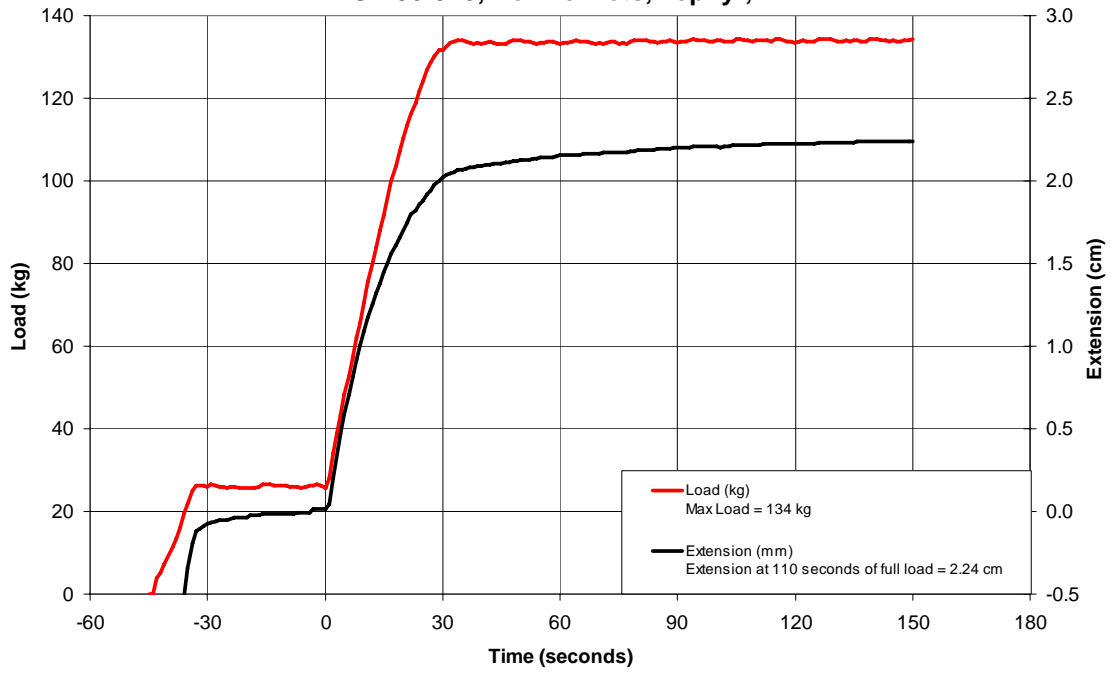




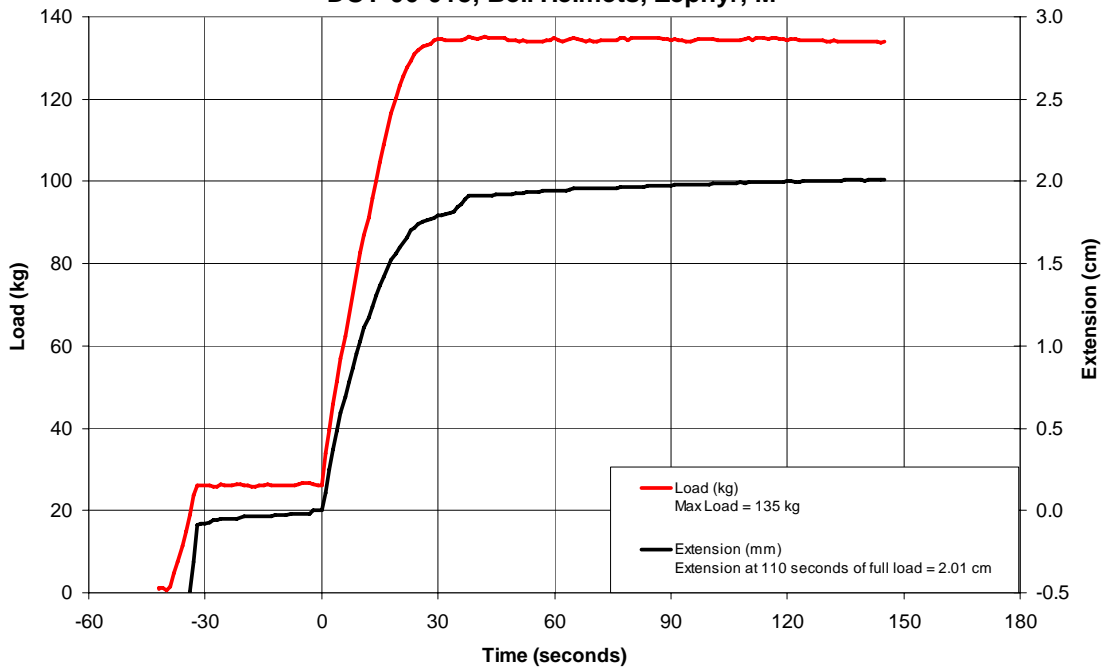
3 RETENTION TIME HISTORIES



High Temperature Retention Testing 08/10/06 DOT-06-018, Bell Helmets, Zephyr, M



Water Immersed Retention Testing 08/10/06 DOT-06-018, Bell Helmets, Zephyr, M



SECTION 4

TEST FAILURE DETAILS

None

APPENDIX A INTERPRETATIONS OR DEVIATIONS FROM FMVSS NO. 218

All testing was performed in accordance with the requirements of FMVSS NO. 218.

APPENDIX B EQUIPMENT LIST AND CALIBRATION INFORMATION

Table 1 - Instrumentation List for SwRI Protective Headgear Testing

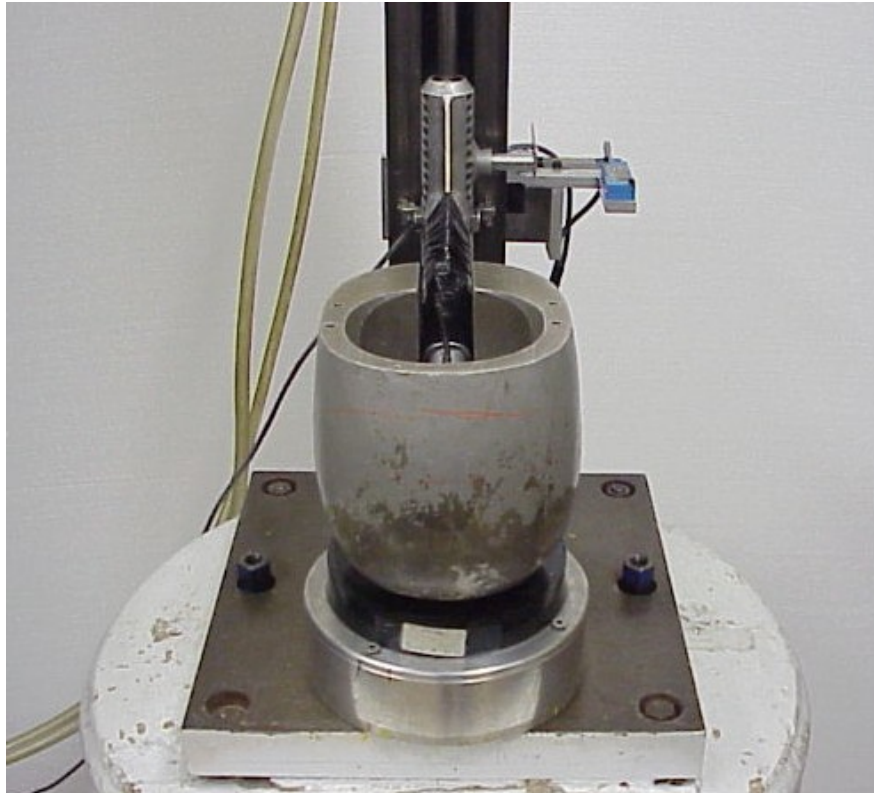
ITEM NO.	DESCRIPTION	MANUFACTURER AND MODEL	SERIAL NO	ACCURACY	DATE OF LAST CALIB.	DATE OF NEXT CALIB.
1	Humidity and Temperature Input Module	Omega / OM5-II-4-20	9213-150149-08	System Software Validation Procedure	11/02/00	NA
	Filter	Frequency Devices, Inc. / 5BAF-LPBU4 4 Pole Butterworth 1.75 KHz	None			
	Data Acquisition Card	National Instruments PCIMIO-16E-4	None			
	Data Acquisition Software	National Instruments / Labview for Windows	Ver 4.1			
	Data Acquisition Computer	Dell Computer Dim. XPS M166s	2170089			
2	Humidity and Temperature Transmitter	Omega / HX41	0599-6004	Manufacturer's Specification and System Software Validation Procedure	03/28/06	03/28/07
	Isolated Voltage Output	Burr Brown / PCI-5B41-02	None			
3	Thermocouple Wire and Thermocouple Input Module	Omega / OM5-LTC-J2-C	21266 21261 21253	Thermocouple Cal Procedure	07/04/06	07/04/07
4	Optical Velocity Transducer	SwRI / 1	1	Velocity Gate Cal Procedure	07/04/06	07/04/07
5	Test Accelerometer	Endevco / 2262-1000	NL05	Accelerometer Cal Procedure	07/04/06	07/04/07
	Strain Gage Conditioner	Measurement Group Inc. / 2120A	102130			
	Strain Gage Power Supply	Measurements Group Inc. / 2110A	102034			
	Filter	Frequency Devices, Inc. / 5BAF-LPBU4 4 Pole Butterworth 1.75 KHz	None			
6	Load Cell	Western / 51	830-7X	Load Cell Cal Procedure	07/04/06	07/04/07
	Strain Gage Conditioner	Measurement Group Inc. / 2120A	102130			
	Strain Gage Power Supply	Measurements Group Inc. / 2110A	102034			
	Isolated Voltage Output	Burr Brown / PCI-5B41-02	None			
7	Potentiometer	Humphrey / RP14-0601-1	87	Potentiometer Cal Procedure	07/04/06	07/04/07
	Isolated Voltage Output	Burr Brown / PCI-5B41-02	None			
8	Scale	Ohaus Scale Corp / 20 Kg / 45 lb	SwRI 5485	Manufacturer's Specification	03/17/06	10/17/06

Table 2 - Test Apparatus List for SwRI Protective Headgear Testing Requiring One Time Dimensions Checks or No Calibration

ITEM NO.	DESCRIPTION	MANUFACTURER	MODEL	SERIAL NO.	ACCURACY	DATE OF DIMENSIONAL CHECK
1	DOT Headforms	Controlled Casting	Small, Medium, and Large	None	+0.31 inches	6/89
2	Monorail Drop Test System	SwRI	1	1	TP-218-04	1/80
3	Drop Assembly	SwRI	Small, Medium, and Large	None	TP-218-04	6/89
4	Modular Elastomeric Programmer (MEP)	U.S Testing	None	None	N/A	N/A
5	Penetration Test System	SwRI	1	1	TP-218-04	1/80
6	Penetration Striker	SwRI	1	1	TP-218-04	1/80
7	Retention Test System	SwRI	1	1	TP-218-04	1/80
8	Chin Strap Fixture	SwRI	1	1	TP-218-04	1/80
9	Static Weights (Steel)	SwRI	1	1	±0.1 lbs.	2/94
10	Hydraulic Cylinder	Enerpac	RD46	1	N/A	N/A
11	Hydraulic Pump	Delta Power Hydraulic Company	B2	NA	N/A	N/A
12	Environmental Conditioner	EDPAC	Mini Tech 90	None	N/A	N/A
13	Oven with Digitronic Control	Despatch Industries Inc.	LDB1-69	128710	N/A	N/A
14	Freezer with Omega Temperature Controller	Sears	9105010 CN100TC	S10204102 6 4011302	N/A	N/A
15	Peripheral Vision Template	SwRI	1	1	±15 min	1/80
16	HPI Indicator	SwRI	Small, Medium, Large	None	NA	NA
17	Test Line Marking System	SwRI	1	1	TP-218-04	1/80

APPENDIX C PHOTOGRAPHS

Test Equipment Photos



SwRI Helmet Test Equipment Photo 1. Monorail Impact Tester with MEP Pad, DOT Headform, SwRI Drop Assembly, and Velocity Gate



SwRI Helmet Test Equipment Photo 2. Flat Anvil Impact Configuration



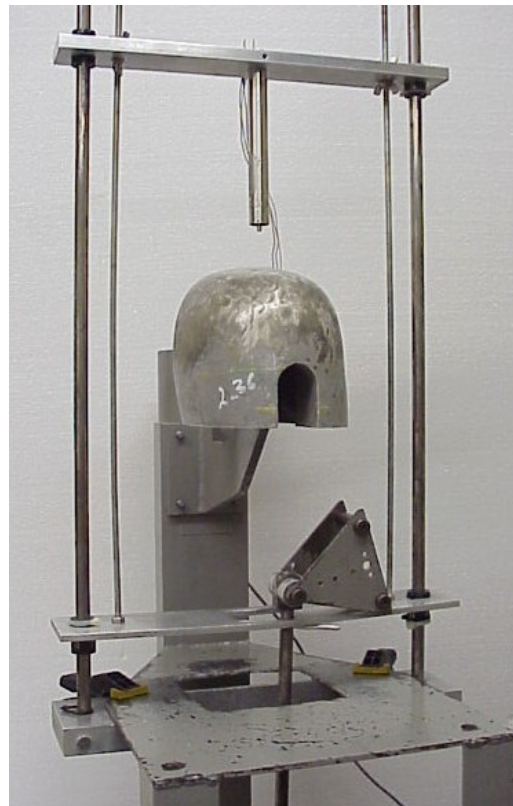
SwRI Helmet Test Equipment Photo 3. Hemispherical Anvil Impact Configuration



**SwRI Helmet Test Equipment Photo 4.
Penetration Resistance Tester Configured for
Crown Locations**



**SwRI Helmet Test Equipment Photo 5.
Penetration Resistance Tester Configured for
Side, Front, and Rear Locations**



**SwRI Helmet Test Equipment Photo 6. Retention System Tester with Supported DOT Headform,
Simulated Jaw, and Displacement Measuring System**

Helmet Photographs



Helmet Photograph 1. Front View Bell Helmets, Zephyr, M



Helmet Photograph 2. Side View Bell Helmets, Zephyr, M



Helmet Photograph 3. Rear View Bell Helmets, Zephyr, M



Helmet Photograph 4. Top View Bell Helmets, Zephyr, M



Helmet Photograph 5. Interior View Bell Helmets, Zephyr, M



Helmet Photograph 6. Labeling Bell Helmets, Zephyr, M



Helmet Photograph 7. Labeling Bell Helmets, Zephyr, M



Helmet Photograph 8. Labeling Bell Helmets, Zephyr, M