

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

Arai Helmet Ltd., Model – Profile
Size – Medium 57 to 58 cm

Prepared By

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16. Abstract Compliance tests were conducted on the Arai Helmet Ltd. Model Profile 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: Impact (S5.1, S7.1) dwell time failure of 2.02 msec at 200g during the low temperature helmet test, Drop No. 2 onto the flat anvil at the right side location.			
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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:	Arai
Helmet Model Designation:	Profile
Helmet Manufacturer:	Arai Helmet Ltd.
Helmet Size Designation:	Medium 57 to 58 cm
Helmet Coverage:	Complete
Helmet Position Index (HPI) (cm):	5.0
Shell Material:	Fiberglass Reinforced Polyester Resin
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	Spiral Red	Spiral Red	Spiral Red	Spiral Red	Spiral Red
Weight (grams)	1510	1515	1497	1497	1506
Month & Year of Manufacture	08/2005	08/2005	08/2005	08/2005	08/2005

Comments:

The HPI was 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	FAIL	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: Dwell time failure of 2.02 msec at 200g during the low temperature helmet test, Drop No. 2 onto the flat anvil at the right side location.

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, Medium 57 to 58 cm. 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.

Arai, Profile, Medium 57 to 58 cm
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	54

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	114	4.71	398	2.06	1.76
	2A	114	4.71	398	2.06	1.76
	3A	114	4.70	399	2.06	1.76
Pre Test Average		---	---	398	---	---
Post Test	1B	114	4.70	399	2.06	1.76
	2B	114	4.71	399	2.08	1.78
	3B	114	4.70	400	2.06	1.76
Post Test Average		---	---	399	---	---
Difference Between Pre Test and Post Test Averages				1	Difference Not to Exceed 40 g's	

Arai, Profile, Medium 57 to 58 cm
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	160	171	141	143	224	248	206	214
		ms @ 150 g	0.74	1.26	0.00	0.00	2.90	2.82	2.82	3.14
		ms @ 200 g	0.00	0.00	0.00	0.00	1.62	2.00	0.28	1.50
		Velocity m/sec	5.14	5.12	5.21	5.14	5.94	5.95	5.94	5.84
B	Low Temperature	Anvil	Hemi		Hemi		Flat		Flat	
		Test Record No.	5	6	13	14	21	22	29	30
		Peak g	166	163	146	155	222	245	208	220
		ms @ 150 g	0.98	1.32	0.00	0.34	2.84	2.92	2.94	3.08
		ms @ 200 g	0.00	0.00	0.00	0.00	1.34	2.02	0.48	1.62
		Velocity m/sec	5.13	5.20	5.21	5.14	5.96	5.95	5.94	5.95
C	High Temperature	Anvil	Hemi		Hemi		Flat		Flat	
		Test Record No.	7	8	15	16	23	24	31	32
		Peak g	124	142	126	122	205	226	193	205
		ms @ 150 g	0.00	0.00	0.00	0.00	3.02	3.02	2.98	3.04
		ms @ 200 g	0.00	0.00	0.00	0.00	0.36	1.90	0.00	0.32
		Velocity m/sec	5.13	5.13	5.14	5.14	5.84	5.94	5.94	5.94
D	Water Immersed	Anvil	Hemi		Hemi		Flat		Flat	
		Test Record No.	9	10	17	18	25	26	33	34
		Peak g	117	131	119	120	190	201	193	201
		ms @ 150 g	0.00	0.00	0.00	0.00	2.98	3.02	3.08	3.20
		ms @ 200 g	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Velocity m/sec	5.13	5.13	5.22	5.20	5.94	5.94	5.95	5.94

Comments: The helmet failed the impact testing. Dwell time failure of 2.02 msec at 200g during the low temperature helmet test, Drop No. 2 onto the flat anvil at the right side location. This is Test Record No. 22.

Recorded by: Manny Gonzales

Approved by: Daniel Pomerening

May 8, 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 296.0 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	53

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	1.40	1.40
B	Low Temperature	0.00	1.34	1.34
C	High Temperature	0.00	1.41	1.41
D	Water Immersed	0.00	1.61	1.61

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 and 12

Comments: Two plastic vent covers are located above the test line with parts above or below 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:

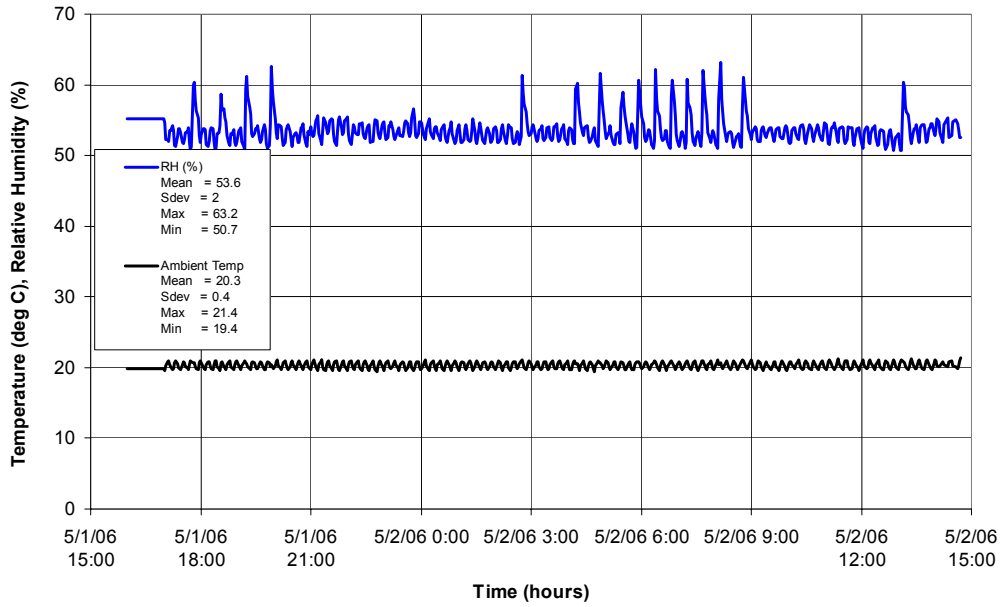
REQUIRED INFORMATION	PASS	FAIL
(1) Manufacturer's name or identification.	PASS	
(2) Precise model designation.	PASS	
(3) Size.	PASS	
(4) Month and year of manufacture.	PASS	
(5) The DOT symbol, constituting the manufacturer's certification that the helmet conforms to the applicable Federal Motor Vehicle 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

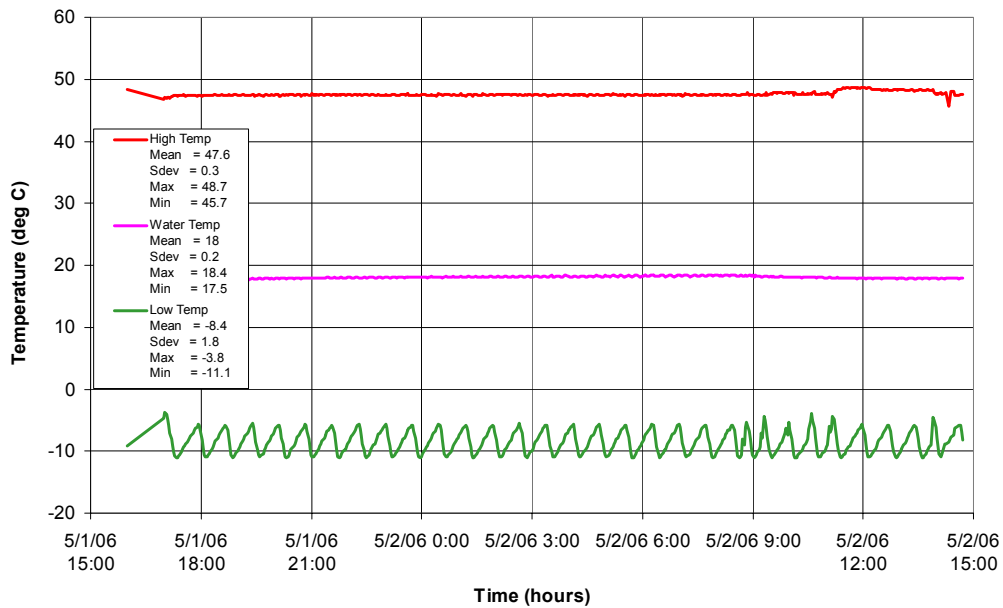
SECTION 3. TEST DATA

1 CONDITIONING ENVIRONMENTS

Environmental Monitoring 6002, Arai, Profile, Medium 57 to 58 cm

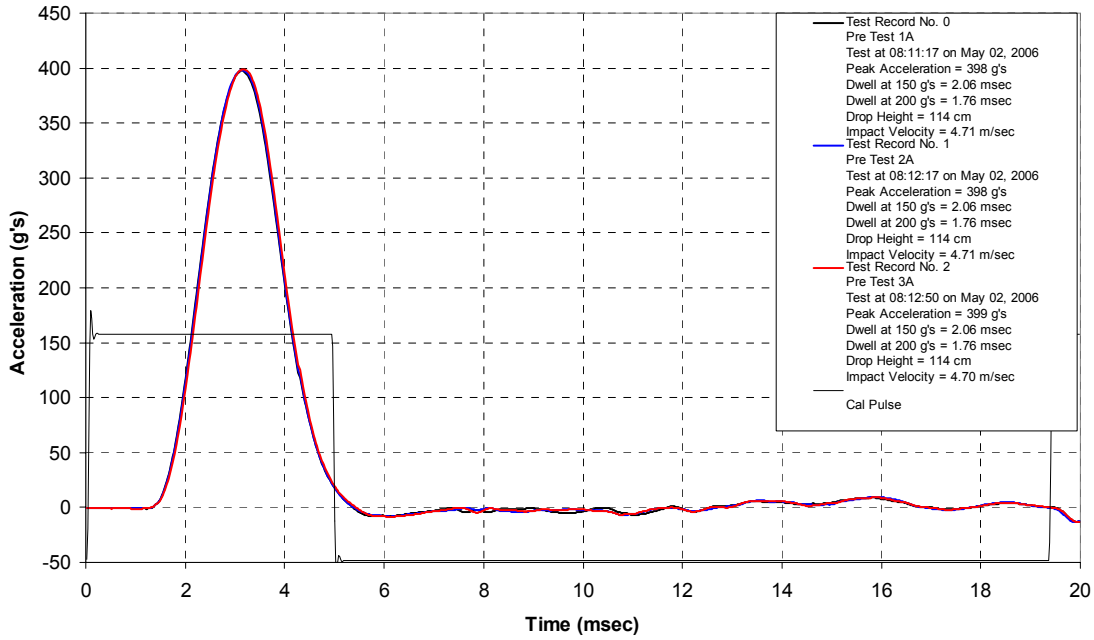


Environmental Monitoring 6002, Arai, Profile, Medium 57 to 58 cm

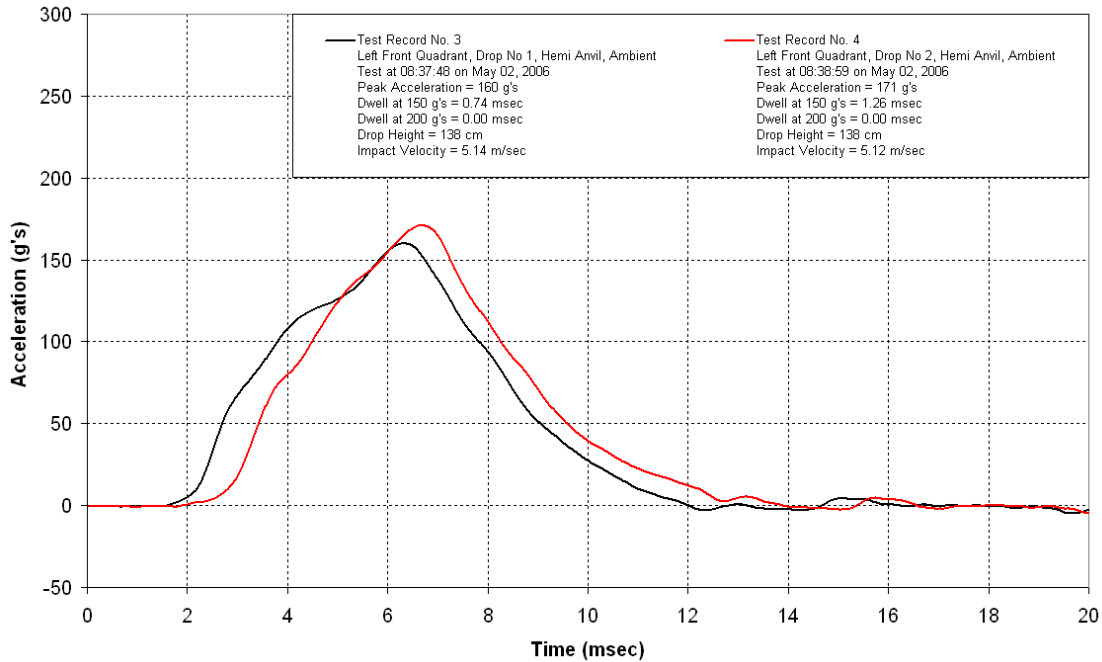


2 IMPACT TIME HISTORIES

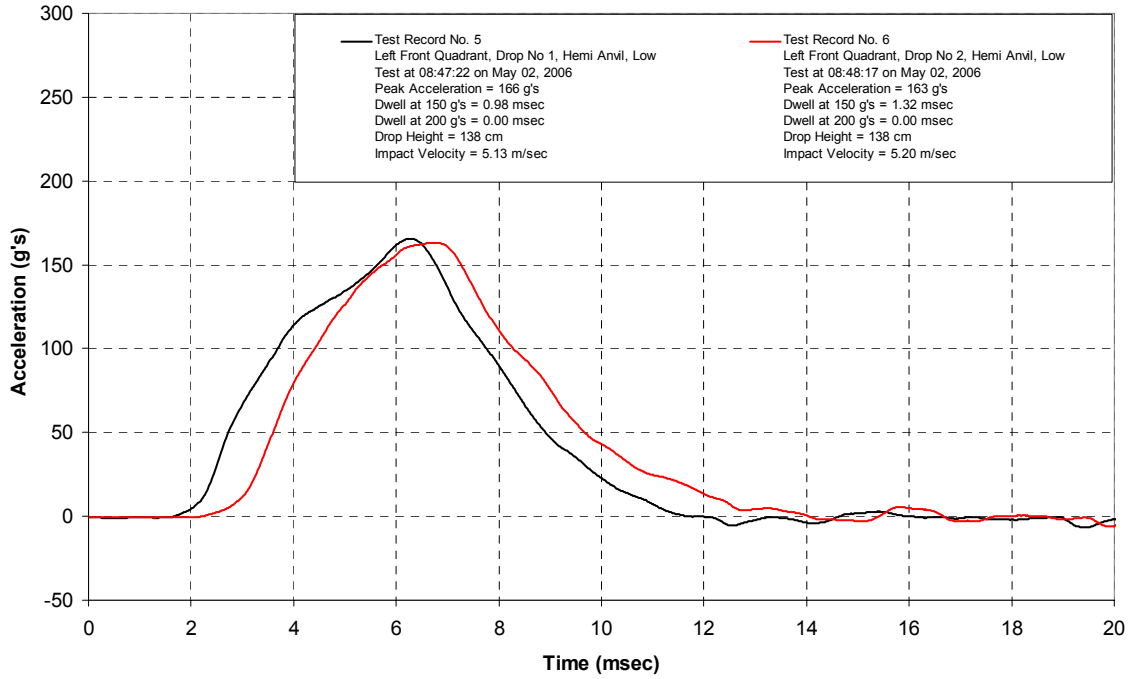
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DOT-06-002, Arai Profile, Medium 57 to 58 cm



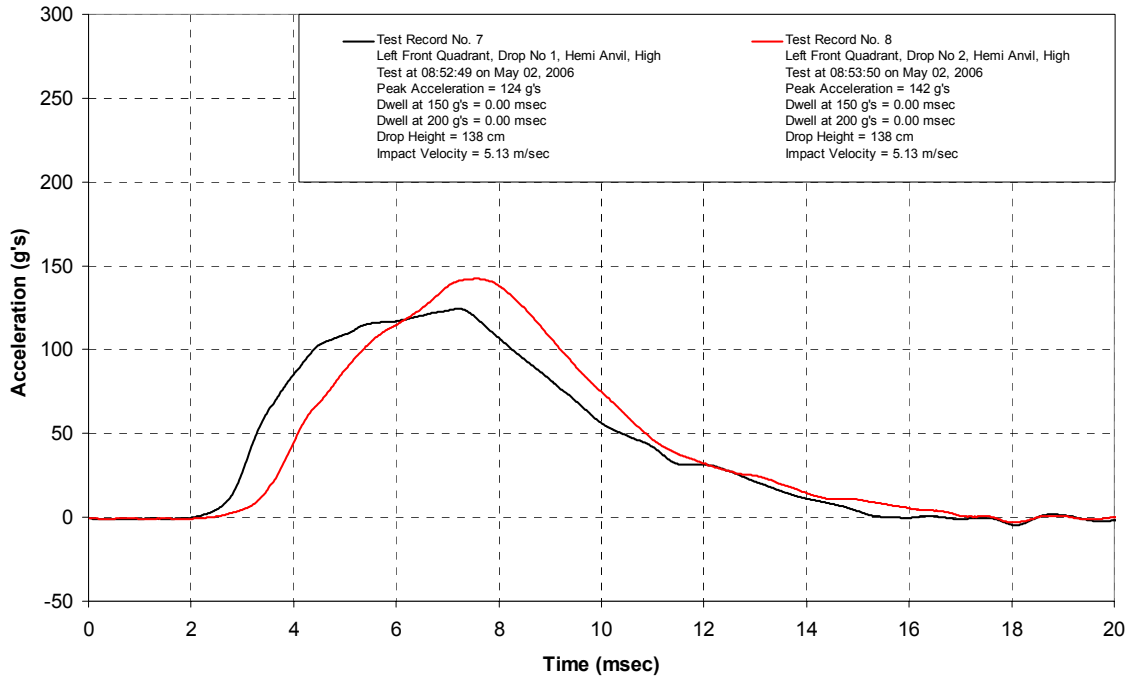
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DOT-06-002, Arai Profile, Medium 57 to 58 cm



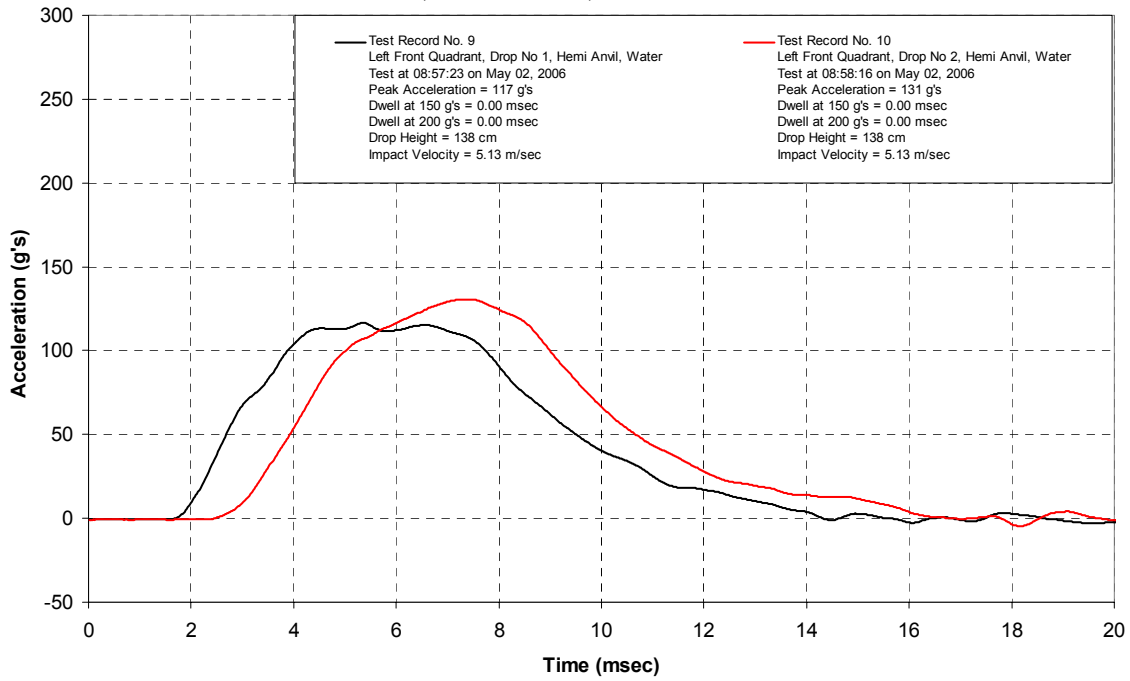
Impact Testing DOT-06-002, Arai Profile, Medium 57 to 58 cm



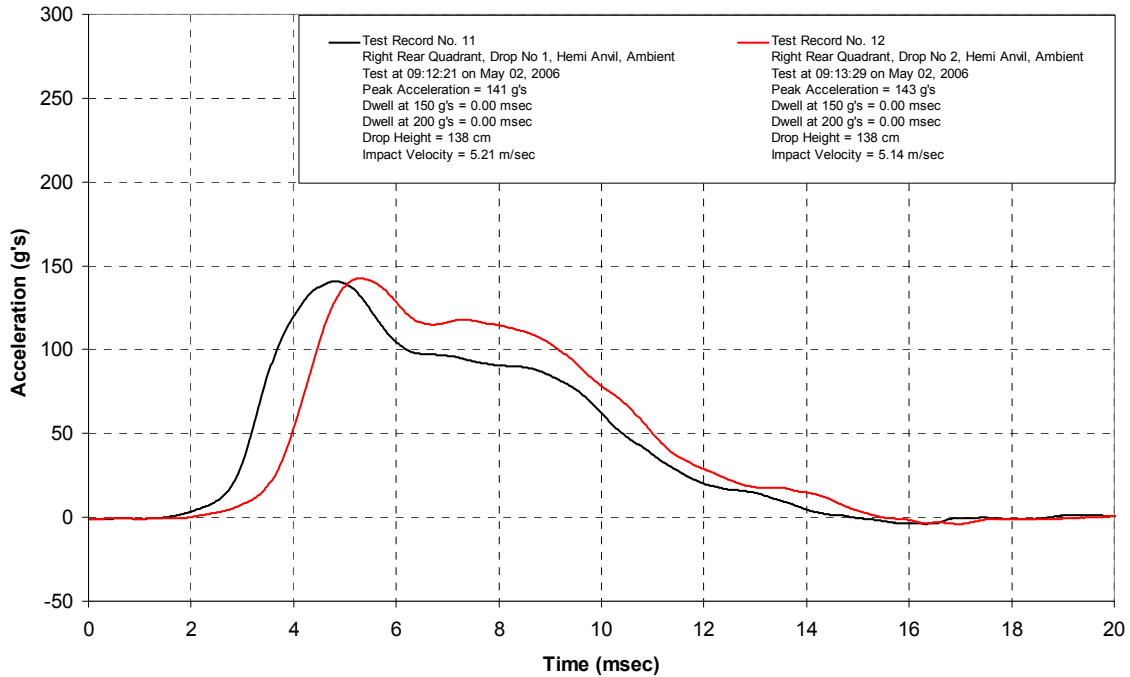
Impact Testing DOT-06-002, Arai Profile, Medium 57 to 58 cm



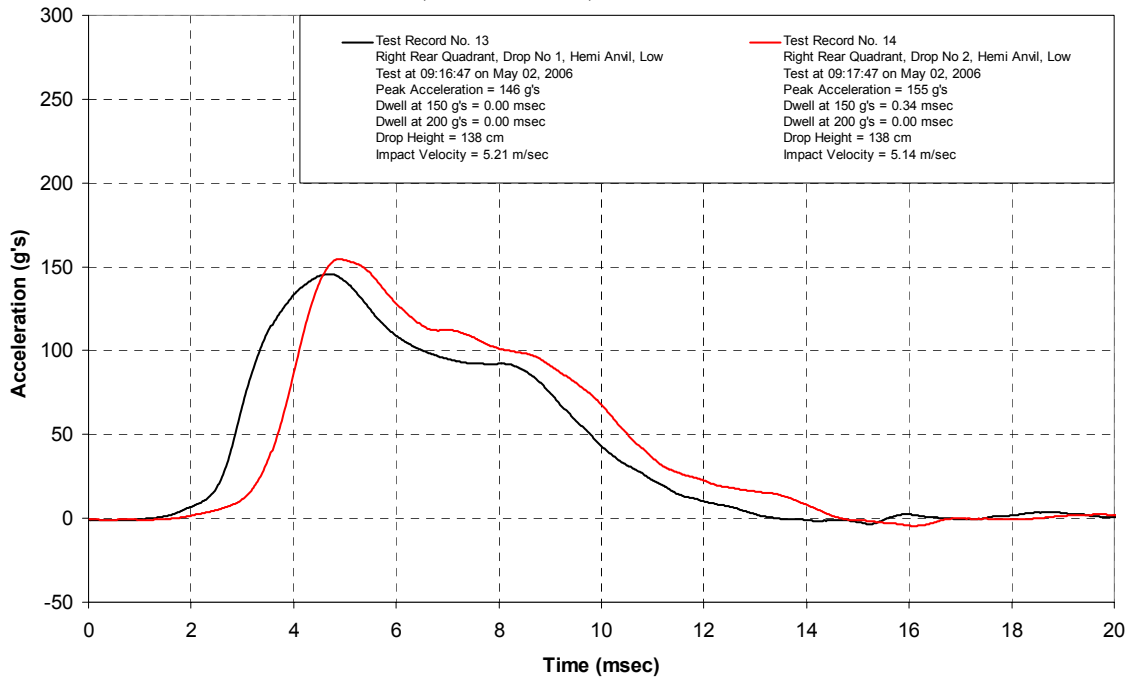
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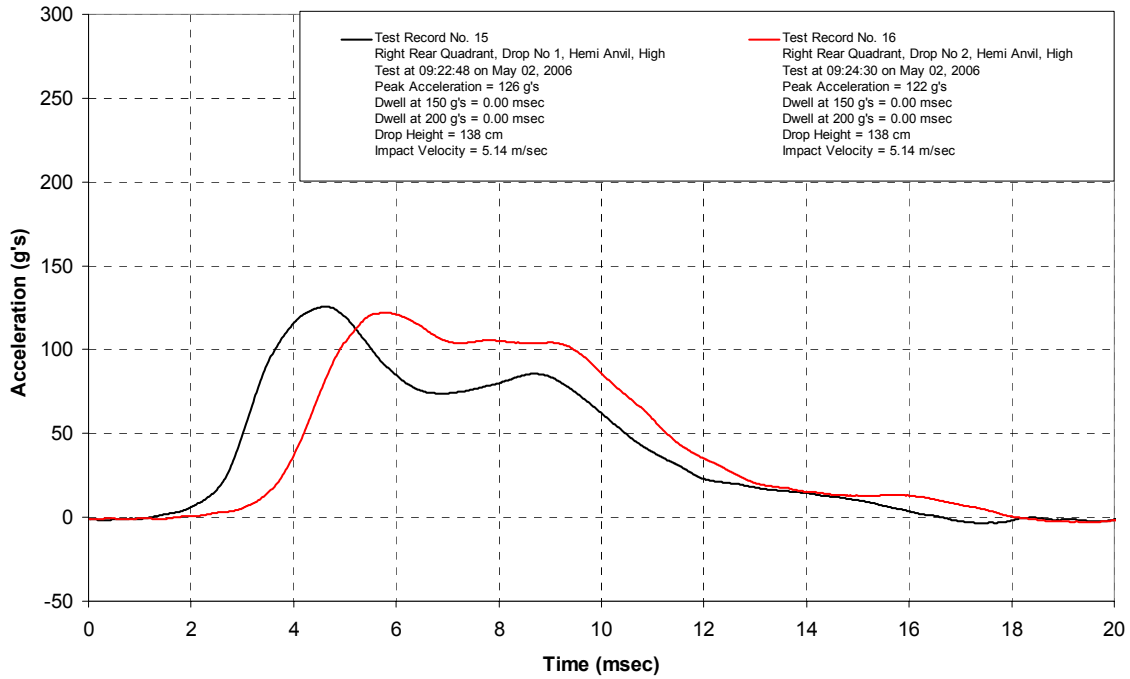
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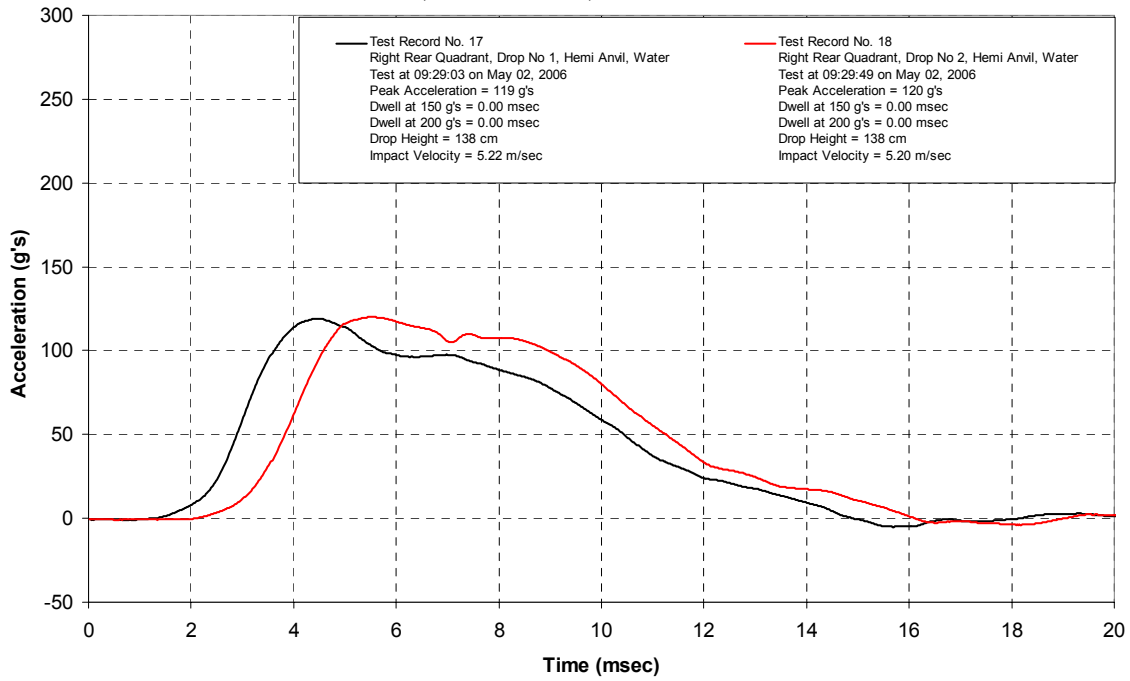
Impact Testing DOT-06-002, Arai Profile, Medium 57 to 58 cm



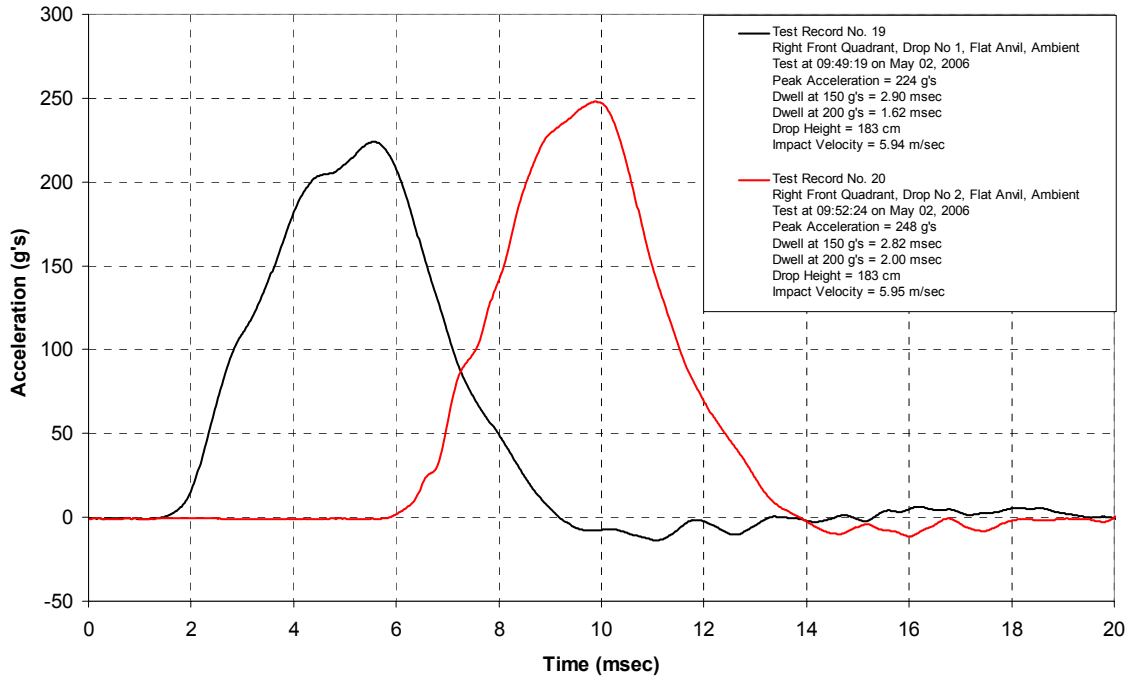
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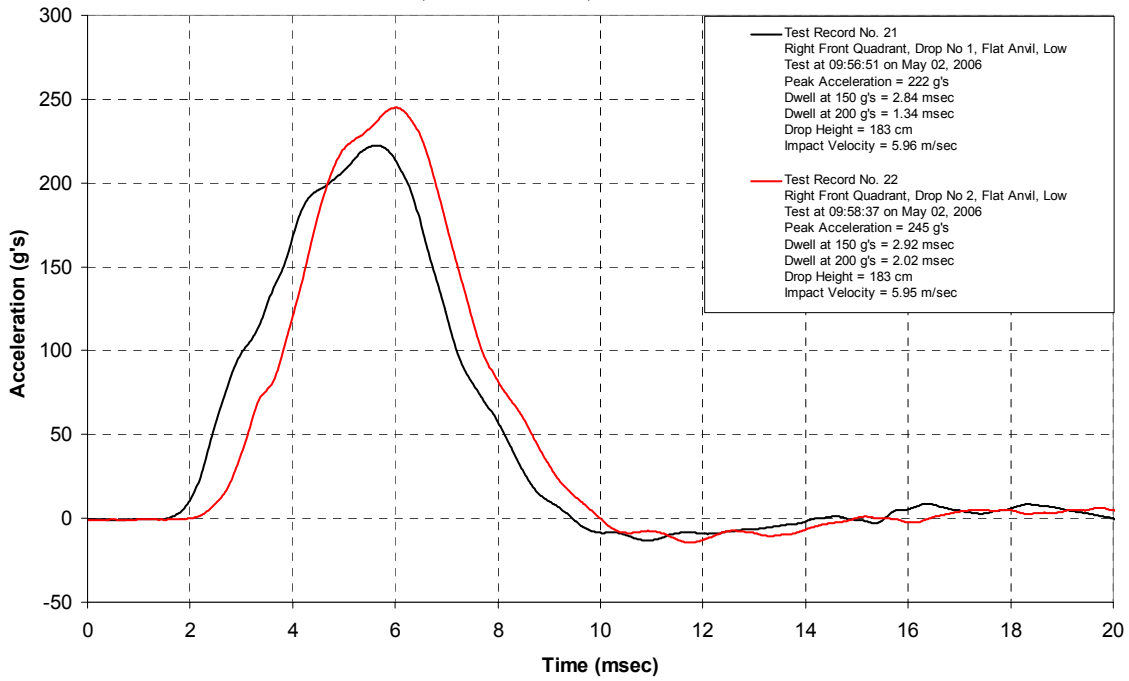
Impact Testing DOT-06-002, Arai Profile, Medium 57 to 58 cm



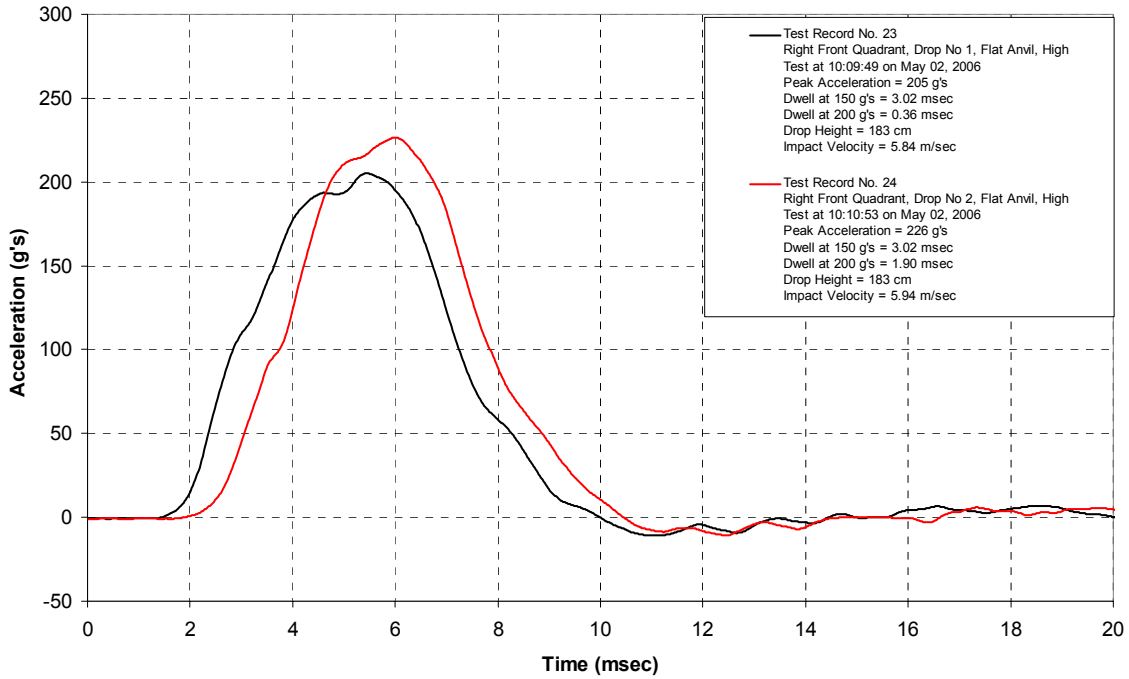
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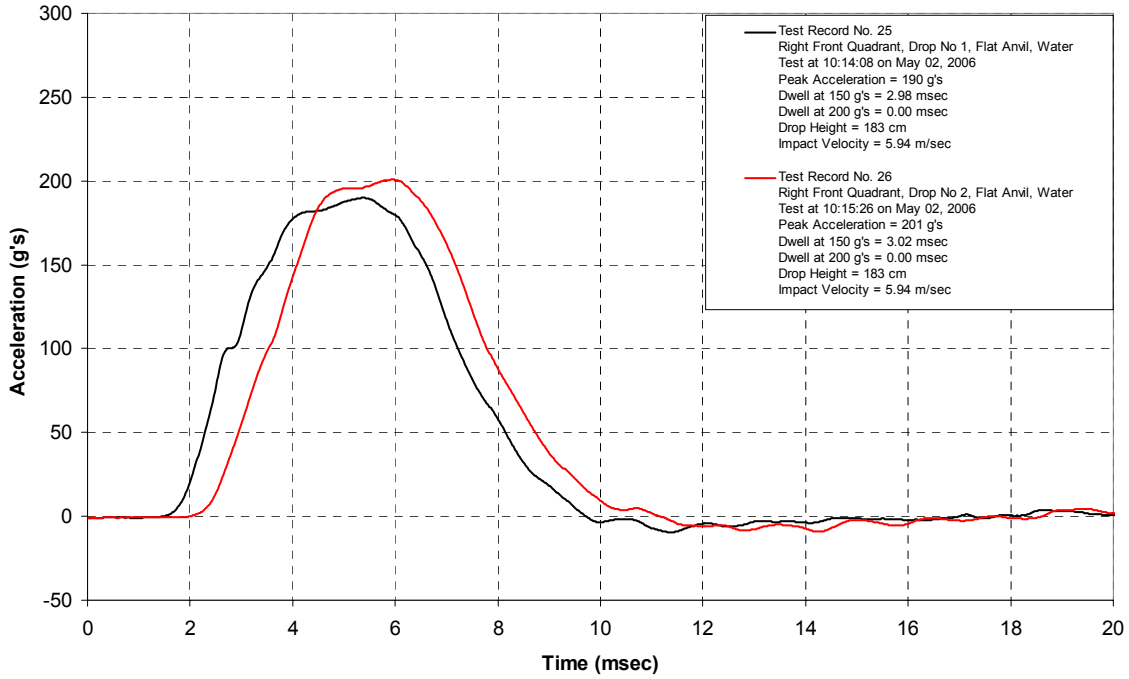
Impact Testing DOT-06-002, Arai Profile, Medium 57 to 58 cm



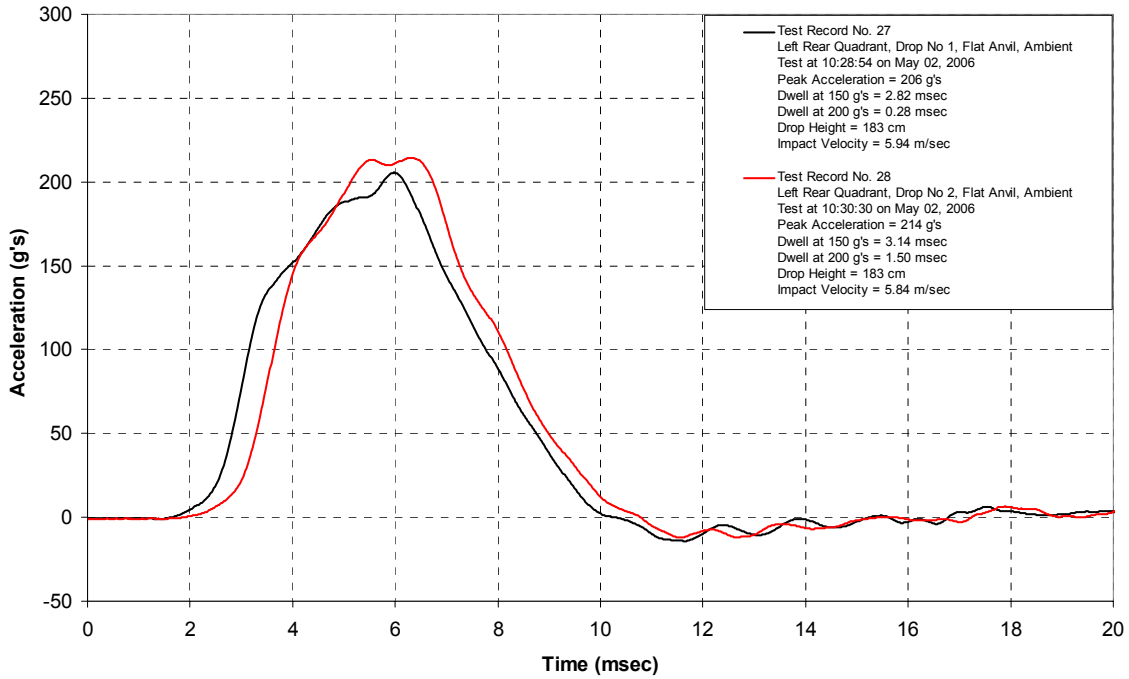
Impact Testing DOT-06-002, Arai Profile, Medium 57 to 58 cm



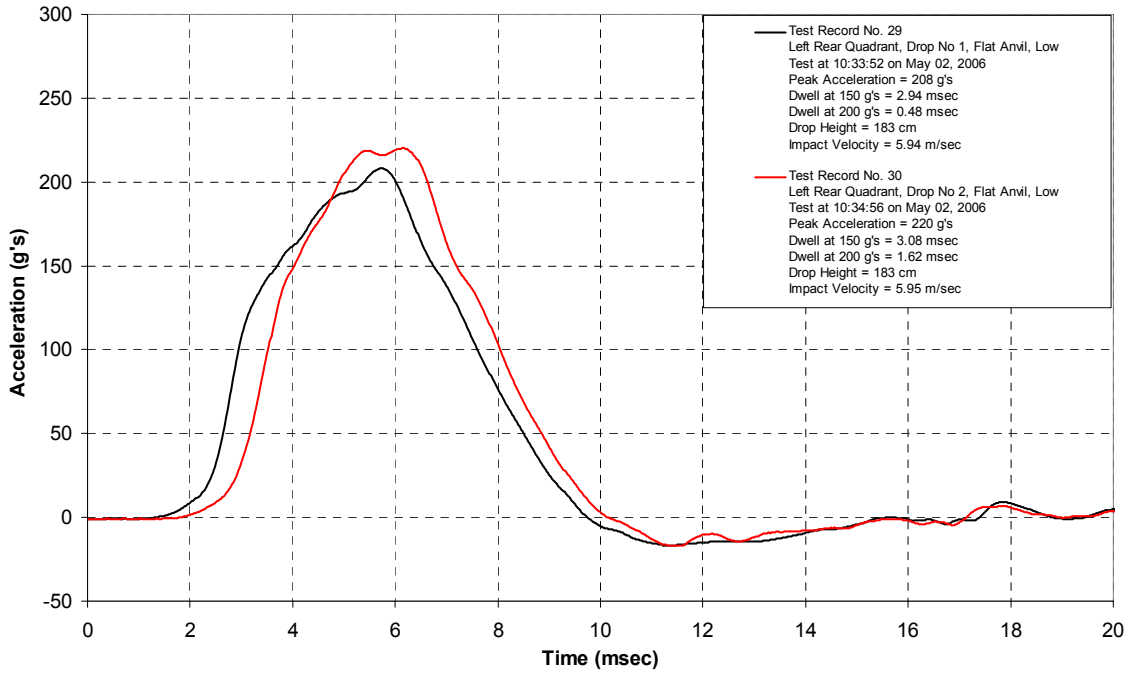
Impact Testing DOT-06-002, Arai Profile, Medium 57 to 58 cm



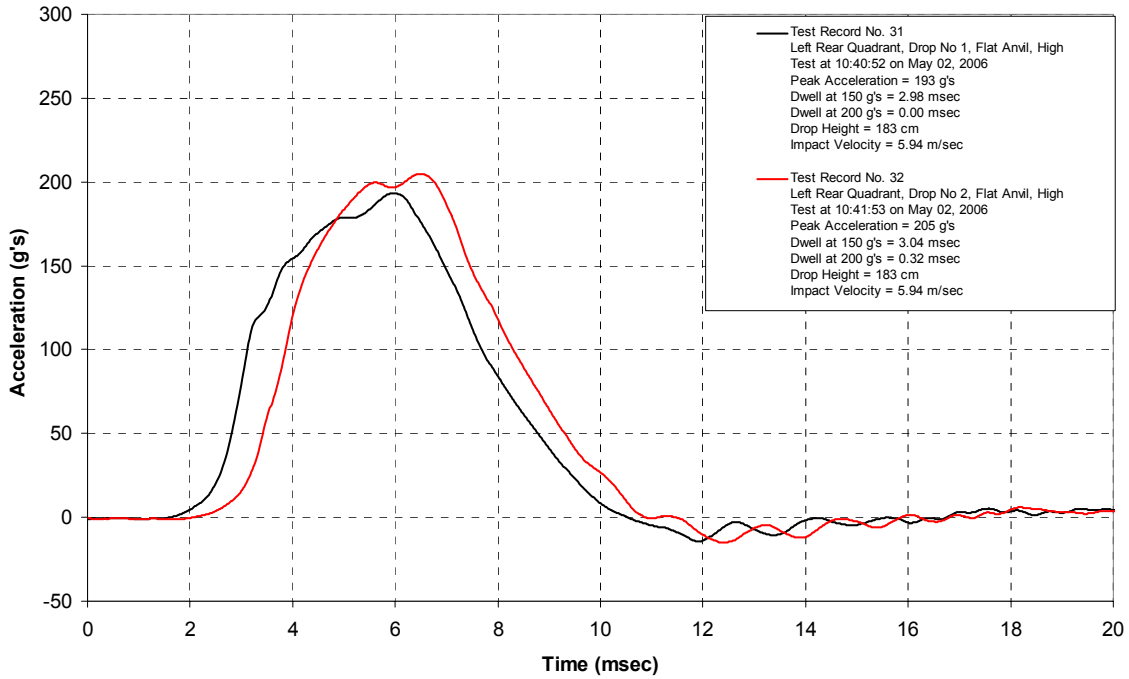
Impact Testing DOT-06-002, Arai Profile, Medium 57 to 58 cm



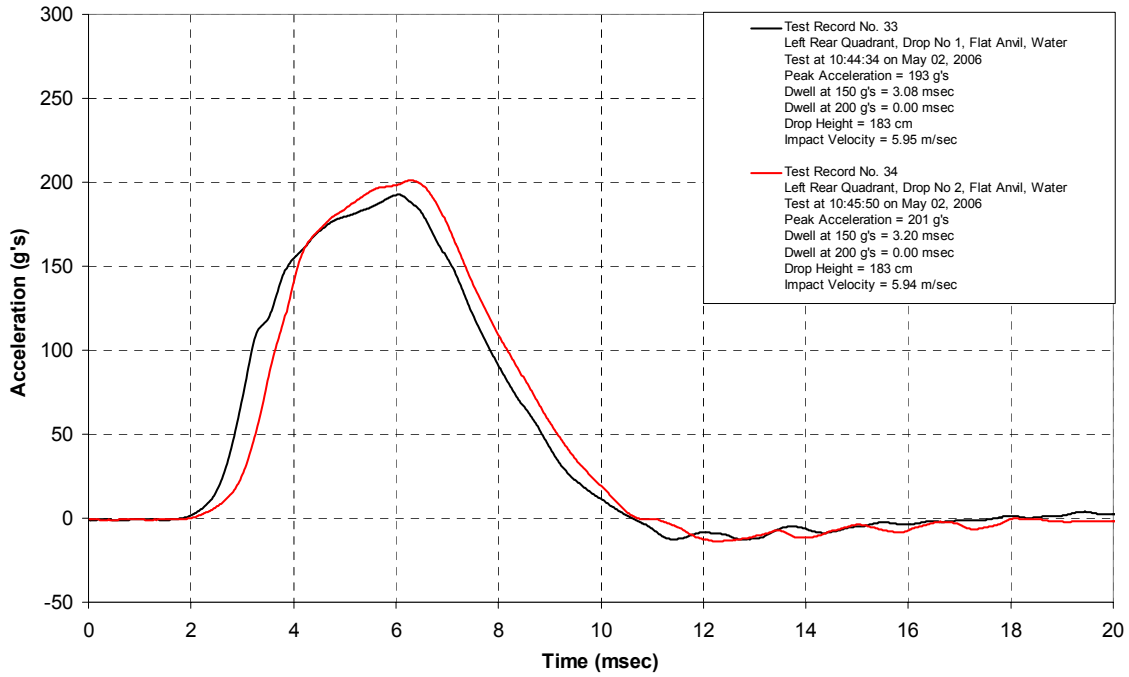
Impact Testing DOT-06-002, Arai Profile, Medium 57 to 58 cm



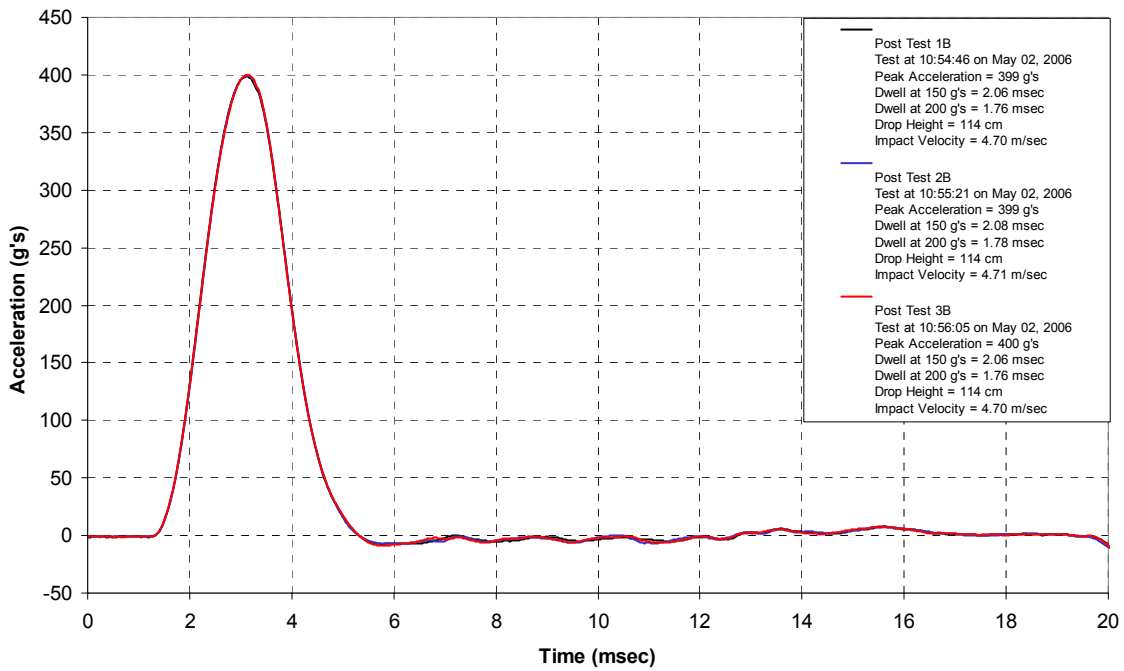
Impact Testing DOT-06-002, Arai Profile, Medium 57 to 58 cm



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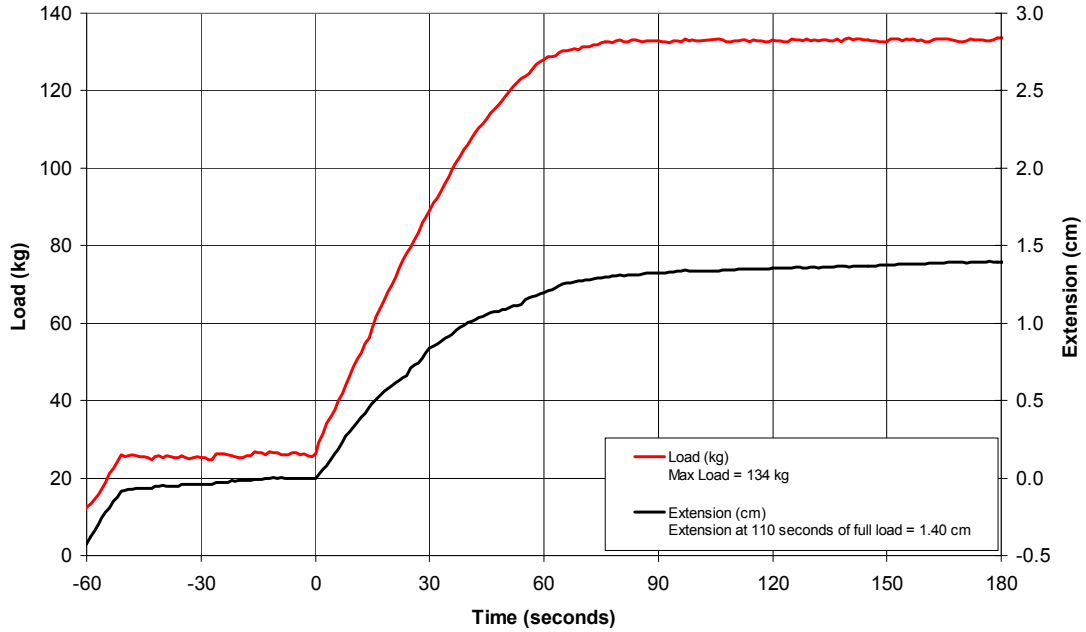


Impact Testing DOT-06-002, Arai Profile, Medium 57 to 58 cm

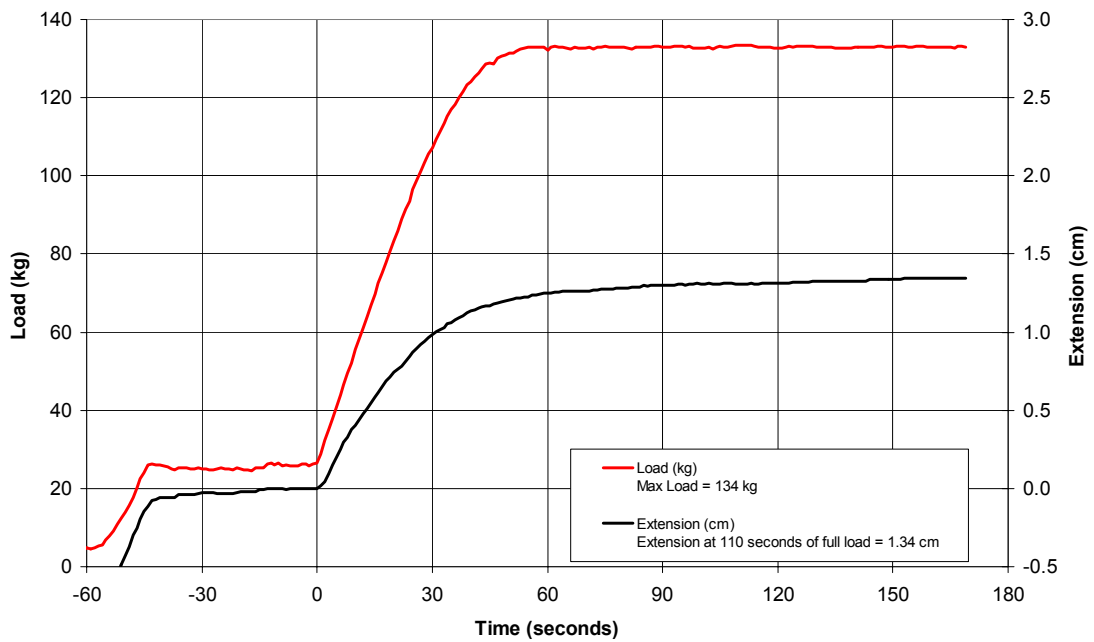


3 RETENTION TIME HISTORIES

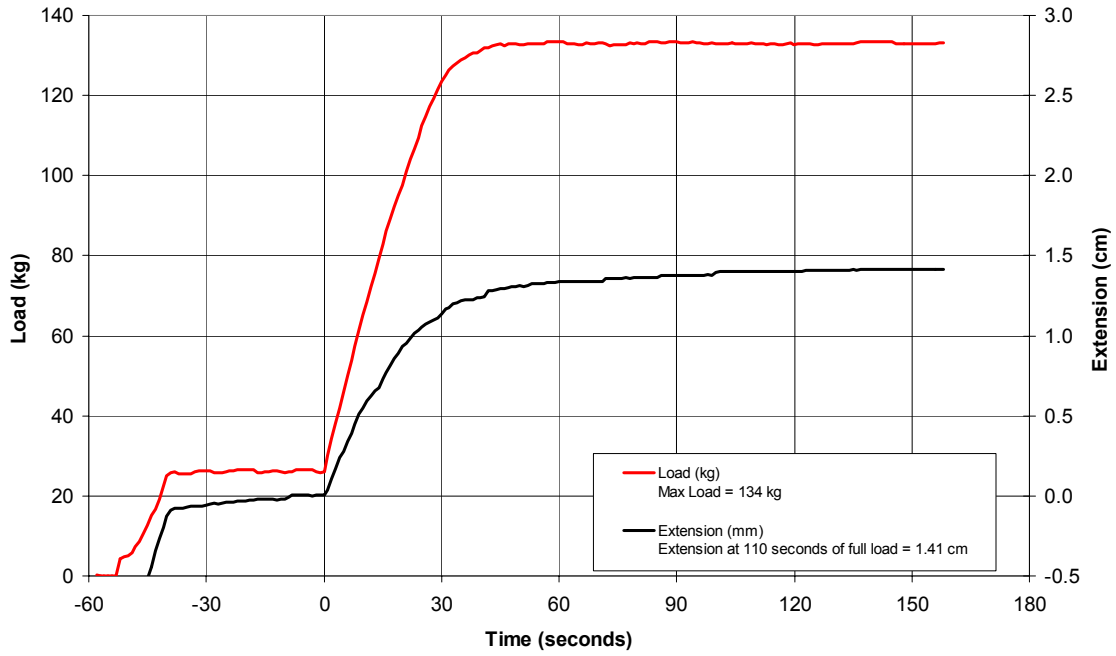
Ambient Temperature Retention Testing 05/02/06
DOT-06-002, Arai, Profile, Medium 57 to 58 cm



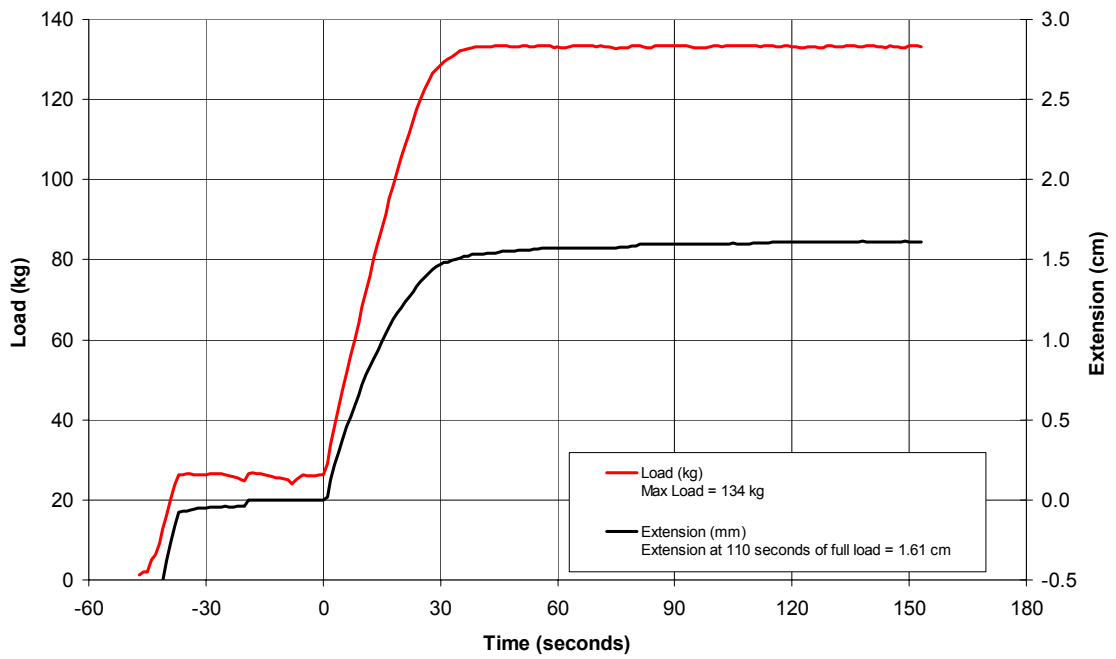
Low Temperature Retention Testing 05/02/06
DOT-06-002, Arai, Profile, Medium 57 to 58 cm



High Temperature Retention Testing 05/02/06 DOT-06-002, Arai, Profile, Medium 57 to 58 cm



Water Immersed Retention Testing 05/02/06 DOT-06-002, Arai, Profile, Medium 57 to 58 cm



SECTION 4 TEST FAILURE DETAILS

The helmet failed the impact testing. Dwell time failure of 2.02 msec at 200 g during the low temperature helmet test, Drop No. 2 onto the flat anvil at the right side location. This is Test Record No. 22. The digital data was consistent with the plot data and the ASCII data file. Although not test failures, it was noted that helmets conditioned at both ambient and high temperature conditions performed similarly. The Ambient helmet had a dwell time of 2.00 msec at 200 g for this location on the second drop. The High Temperature helmet had a dwell time of 1.90 msec at 200 g for this location on the second drop.

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

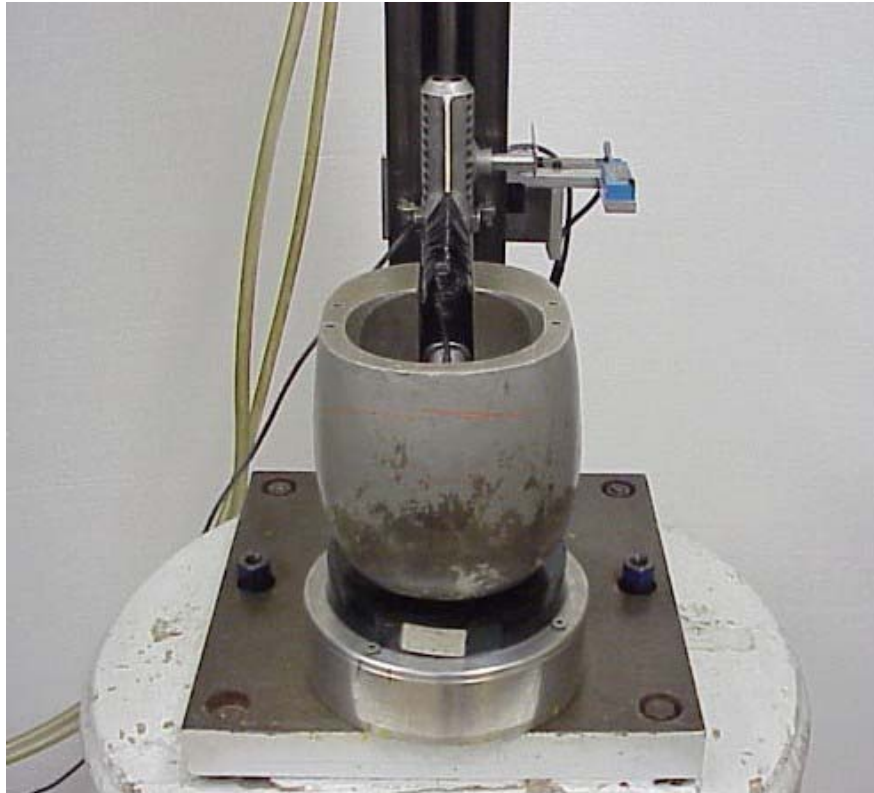
ITEM NO.	DESCRIPTION	MANUFACTURER AND MODEL	SERIAL NO	ACCURACY	DATE OF LAST CALIB.	DATE OF NEXT CALIB.	PERSON DOING CALIB.
1	Humidity and Temperature Input Module	Omega / OM5-II-4-20	9213-150149-08	System Software Validation Procedure	11/02/00	NA	DJP
	Filter	Frequency Devices, Inc. / 5BAF-LPBU4 4 Pole 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	BLT
	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	06/27/05	06/27/06	DJP
4	Optical Velocity Transducer	SwRI / 1	1	Velocity Gate Cal Procedure	06/29/05	06/29/06	DJP
5	Test Accelerometer	Endevco / 2262-1000	NL05	Accelerometer Cal Procedure	07/01/05	07/01/06	SRK
	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	07/04/05	07/04/06	DJP
	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	07/04/05	07/04/06	DJP
	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	10/17/07	LGS

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	S102041026 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 Arai Helmet Ltd., Profile, Medium 57 to 58 cm



Helmet Photograph 2. Side View Arai Helmet Ltd., Profile, Medium 57 to 58 cm



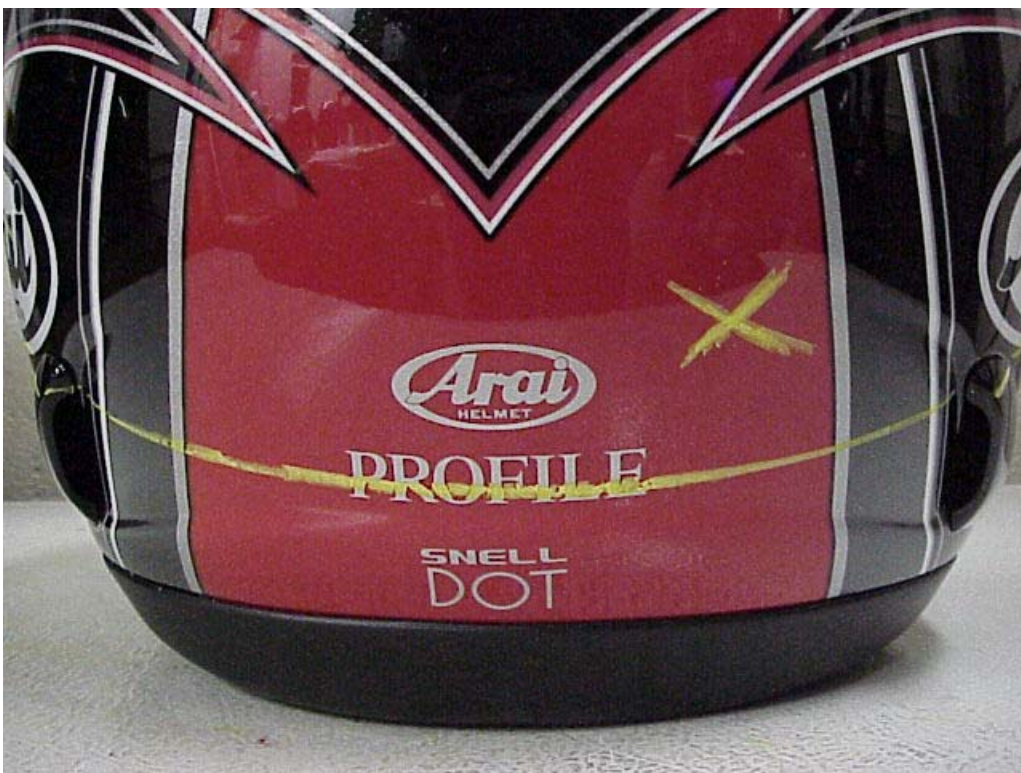
Helmet Photograph 3. Rear View Arai Helmet Ltd., Profile, Medium 57 to 58 cm



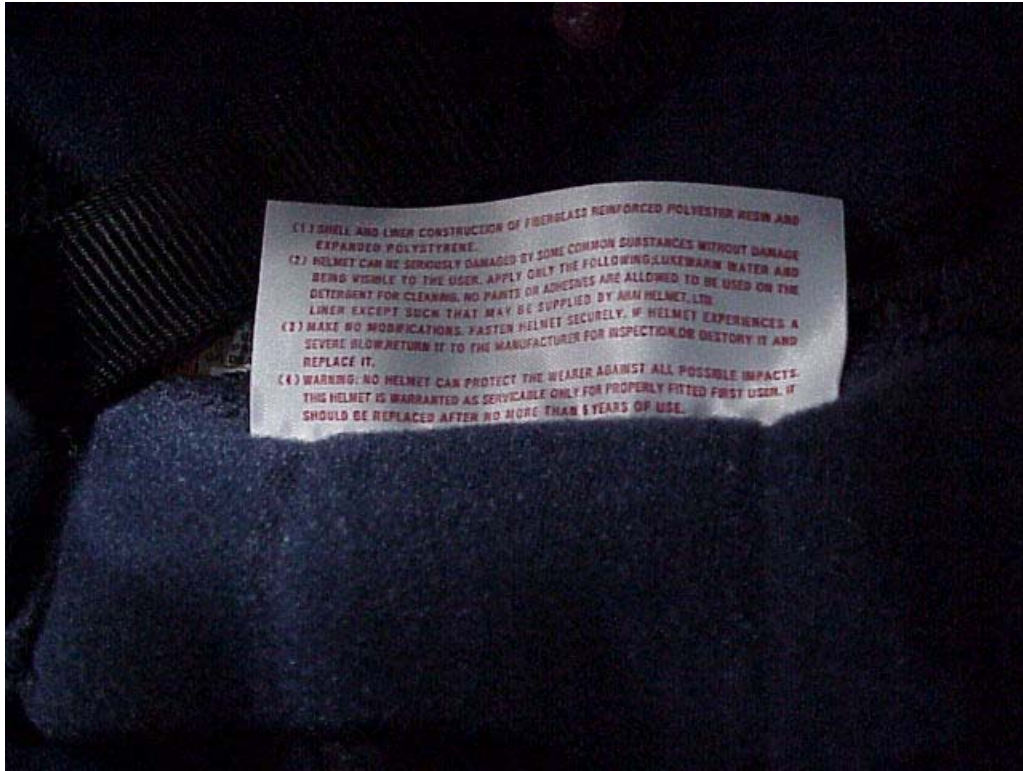
Helmet Photograph 4. Top View Arai Helmet Ltd., Profile, Medium 57 to 58 cm



Helmet Photograph 5. Interior View Arai Helmet Ltd., Profile, Medium 57 to 58 cm



Helmet Photograph 6. Labeling Arai Helmet Ltd., Profile, Medium 57 to 58 cm



Helmet Photograph 7. Labeling Arai Helmet Ltd., Profile, Medium 57 to 58 cm



Helmet Photograph 8. Labeling Arai Helmet Ltd., Profile, Medium 57 to 58 cm