

Sled Impact Test

AS 1602

Aspen Seating LLC / Ride Designs

**Frontal Impact of a Java 18" Tall Back Support with Java Gen-2 Hardware,
Installed on the ISO/RESNA Surrogate Wheelchair Base/Frame (SWCB/SWCF)
with a Surrogate Metal Seat and a 2-inch Thick Cushion
Secured by a Surrogate Four-Point, Strap-Type Tiedown
and Loaded with a Hybrid III Midsize Male ATD
Restrained by a Surrogate Three-Point Belt with a WC-Anchored Lap Belt**


This test was conducted in accordance with standards
RESNA WC-4:2012, Section 20: *Wheelchair Seating Systems for Use in Motor Vehicles*
and ISO 16840 *Wheelchair Seating – Part 4: Seating Systems for Use in Motor Vehicles*


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ACKNOWLEDGEMENT AND TEST PURPOSE

This test was sponsored by the Ride Designs of Littleton, Colorado and was conducted in accordance with procedures in Annex A of RESNA WC-4:2012, Section 20: *Wheelchair Seating Systems for Use in Motor Vehicles*, hereafter referred to as WC20, and in Annex A of ISO 16840-4, *Wheelchair Seating- Part 4: Seating Systems for Use in Motor Vehicles*, hereafter referred to as ISO 16840-4. These standards provide a method for evaluating a complete seating system consisting of back support, seat, and attachment hardware, but the purpose of this test was to evaluate only a wheelchair back support and its attachment hardware. Therefore, a surrogate seat consisting of a steel plate with a 2-inch thick seat cushion was used to comprise a complete wheelchair seating system for testing. The performance of the Java Decaf complete wheelchair back support and attachment hardware were measured and evaluated according to the applicable performance requirements in 5.1 of WC20 and ISO 16840-4.

Advertisements and marketing literature should refer to the requirements and provisions of WC20 and ISO 16840-4, but should not refer to the University of Michigan or the University of Michigan Transportation Research Institute (UMTRI). Requests for copies of this report, test film, and video should be directed to the test sponsor.

TEST METHODS

This frontal impact test was conducted on the UMTRI impact sled. The sled operates on the rebound principle, achieving the desired change in velocity by reversing direction during the impact event. The sled crash pulse is trapezoidal in shape and is reported as an average deceleration level in *g*. The sled velocity is monitored immediately before and after impact.

Data generated during the test were digitized live using a TDAS onboard data acquisition system. All signals were filtered to the requirements of SAE J-211. The photo documentation consisted of high-speed (1000-frames/sec) digital video from right and right-rear side views of the impact event. A strobe flash and simultaneous voltage pulse record and synchronize the onset of impact deceleration on video and transducer signals.

TEST SETUP

The Java 18" Tall Back Support with Java Gen-2 Hardware and a surrogate seat were installed on the ISO/RESNA surrogate wheelchair base/frame (SWCB/SWCF), which was placed on the sled platform facing forward and secured using the surrogate four-point, strap-type tiedown specified in RESNA WC-4:2012, Section 19: *Wheelchairs Used As Seats in Motor Vehicles*. The adjustable width of the SWCB/SWCF was set to 18 inches (measured between the outside edges of the seat rails) prior to testing. The surrogate seat consisted of a 3/8-inch thick steel plate that was attached to the SWCB/SWCF seat rails by rigid metal brackets, and a 2-inch-thick seat cushion attached with Velcro. The Java Gen-2 attachment hardware of the back support was fitted to the back-support posts and the back-support height was adjusted so that the bottom edge of the cane bracket was 14.3 inches above the base of the deformable element fitting. The front tiedown straps were hooked to the securement points provided on the front of the SWCB/SWCF and the rear securement hooks were attached to the lower set of securement points at the back of the SWCB/SWCF.

The seating system was loaded with a Hybrid III midsize-male anthropomorphic test device (ATD) that was restrained by a surrogate three-point belt with a SWCB/SWCF -anchored lap belt. The left end of the lap belt was anchored with three-bar clips to a D-ring attached near the rear securement point on the left side of the SWCB/SWCF, while the right side of the lap belt and the lower portion of the shoulder belt formed a continuous loop through a D-ring that was anchored near the rear securement point on the right side of the SWCB/SWCF. A heavy-duty three-bar clip held the lap and shoulder belts together near the right hip of the ATD. The shoulder-belt upper anchorage was attached to a rigid structure on the sled platform at a position above and behind the ATD's shoulder that simulated a typical vehicle sidewall anchor point. The pelvic belt was tightened to fit snugly over the ATD pelvic region. The shoulder belt was tightened snugly across the ATD chest with a 75-mm block between the belt and ATD, and the block was removed prior to the test.

The test was conducted using 48-kph (30-mph) and 20-g average impact conditions to determine the response of the Java 18" Tall Back Support with Java Gen-2 Hardware during frontal impact loading when installed on the SWCB/SWCF, and compliance of the back support to applicable performance requirements in 5.1 of WC20 and ISO 16840-4. The following table provides further details about the test equipment and setup.

SUMMARY OF TEST SETUP AND PRE-TEST MEASUREMENTS

<p>GENERAL TEST INFORMATION</p> <p>Test number Test date Seating System</p> <p>Wheelchair type Wheelchair tiedown Occupant restraint Anthropomorphic Test Dummy (ATD) Wheelchair orientation Sled platform Desired impact velocity (ΔV) Desired average sled deceleration</p>	<p>AS 1602 December 1, 2016 Java 18" Tall Back Support with Java Gen-2 Hardware and a surrogate seat ISO/RESNA surrogate wheelchair base/frame Surrogate four-point, strap-type tiedown Surrogate three-point belt with SWCF-anchored lap belt Hybrid III midsize male @ 77 kg (170 lb) Forward facing Rigid steel plate 48 kph (30 mph) 20 g</p>
<p>WHEELCHAIR TIEDOWN</p> <p>Front-to-rear anchor-point distance Rear tiedowns Lateral distance between anchor points Angle wrt horizontal Angle wrt to wheelchair center plane Anchor point to rear-wheel hub Length (anchor point to securement point) Front tiedowns Lateral distance between anchor points Angle wrt horizontal Angle wrt to wheelchair center plane Length (anchor point to securement point)</p>	<p>1295 mm (51.0 in) 432 mm (17.0 in) 40 degrees 0 degrees 432 mm (17.0 in) 495 mm (19.5 in) 711 mm (28.0 in) 45 degrees 11 degrees 521 mm (20.3 in)</p>
<p>OCCUPANT RESTRAINT</p> <p>Shoulder belt upper anchor point location Behind ATD shoulder Above ATD shoulder Above sled platform Left of wheelchair centerline Angle of pelvic belt wrt to horizontal Angle of shoulder-belt Projected frontal view wrt horizontal Projected lateral view wrt horizontal Footstrap location In front of ATD knee center Above ATD knee center</p>	<p>305 mm (12.0 in) 178 mm (7.0 in) 1219 mm (48.0 in) 305 mm (12.0 in) 63 degrees 58 degrees, measured on ATD torso 30 degrees, measured above ATD shoulder 483 mm (19.0 in) 0 mm (0.0 in)</p>
<p>ATD POSITIONING</p> <p>Shoulder height above sled platform H-point height above sled platform</p>	<p>1067 mm (42.0 in) 635 mm (25.0 in)</p>
<p>WHEELCHAIR</p> <p>Weight Wheelbase Seatback angle wrt vertical Seatback height (with headrest) Seatpan angle wrt horizontal Seat surface height from floor @ SB junction Seatpan length Back support top edge below ATD shoulder Attachment clamp height above SB junction</p>	<p>55.5 kg (122 lb) 533 mm (21.0 in) 6 degrees 533 mm (21.0 in) 4 degrees 533 mm (21.0 in) 457 mm (18.0 in) 38 mm (1.5 in) 400 mm (15.8 in)</p>

TEST RESULTS

The Java 18" Tall Back Support with Java Gen-2 Hardware remained attached to the back-support posts at both attachment points during frontal-impact loading. The maximum forward excursion of point P on the wheelchair seating system was 75 mm, which is below the WC20 and ISO 16840-4 excursion limit of 200 mm. After the test, the SWCF was upright on the sled platform and the ATD was seated in the wheelchair seat with the torso upright. The ATD could be removed from the belt restraint without the use of tools.

The ATD was effectively restrained from forward excursions by the surrogate three-point belt with a SWCF-anchored lap belt during frontal-impact loading. Peak forward excursion of the ATD's head was limited to approximately 336 mm and peak forward knee excursion was limited to about 243 mm, which are both below the WC20 and ISO 16840-4 limits of 650 mm and 375 mm, respectively. The ATD's head traveled 449 mm rearward of its initial position during the test, which is just below the WC20 and ISO 16840-4 limit of 450 mm. The criterion regarding the change in the ATD's average H-point height is not applicable because a surrogate seat was used for this test.

The results of this test show that the Java 18" Tall Back Support with Java Gen-2 Hardware *meets* all applicable performance criteria for wheelchair back supports in 5.1 of WC20 and ISO 16840-4. The following tables summarize the test results and compliance with applicable performance criteria of WC20 and ISO 16840-4.

SUMMARY OF TEST RESULTS

GENERAL TEST INFORMATION Test number Actual impact velocity (ΔV) Actual average sled deceleration level Actual peak sled deceleration level Total time of deceleration over 20 g Total time of deceleration over 15 g Deceleration pulse duration	AS 1602 49 kph (30.6 mph) 21.2 g 28.3 g 29.6 ms 71.0 ms 78.6 ms
ATD MEASUREMENTS Peak resultant head acceleration Peak resultant chest acceleration Head injury criteria (unlimited) Maximum forward head excursion [†] Maximum forward knee excursion ^{††} Maximum rearward head excursion ^{††} Average post-test H-pt ht above sled platform	49 g 41 g 196 336 mm (13.2 in) 243 mm (9.6 in) 449 mm (17.7 in) 635 mm (25.0 in) 0% change
TIEDOWN LOADS Peak left-rear tiedown strap force Peak right-rear tiedown strap force	16067 N (3612 lb) 20306 N (4565 lb)
BELT LOADS AND PELVIC BELT ANGLE Peak left pelvic-belt load Peak shoulder-belt load	9577 N (2153 lb) 10645 N (2393 lb)
WHEELCHAIR MEASUREMENTS^{††} Maximum forward wheelchair excursion at Point P* Maximum forward excursion of front-wheel hub Maximum forward excursion of rear-wheel hub	75 mm (3.0 in) 51 mm (2.0 in) 55 mm (2.2 in)

[†]The forward head excursion is the total forward change in position of the leading edge of the head, measured at the initial position prior to impact and at the time of maximum forward head travel.

^{††}Excursions reported are the total horizontal change in the position of the affixed targets relative to the sled platform from just prior to impact to the time of maximum forward or rearward excursion.

*Point P is a seating reference point located 50 mm above and 50 mm in front of the junction of the seatback and seat cushion planes.

**SUMMARY OF APPLICABLE BACK SUPPORT
PERFORMANCE CRITERIA IN RESNA WC-4:2012, SECTION 20**

SLED TEST AS 1602

Requirement		Observed Performance	
WC20 Clause	Description	Description	Pass/Fail
5.1a	Forward excursion of Point P < 200 mm	75 mm	Pass
	Forward knee excursion < 375 mm	243 mm	Pass
	Forward head excursion < 650 mm	336 mm	Pass
	Rearward head excursion < 450 mm	449 mm	Pass
5.1b	Seating system shall not completely separate from the SWCF at any attachment point.	The back support remained attached to the back-support posts at both attachment points.	Pass
5.1c	ATD must be in WC seat with torso leaning not more than 45° from vertical.	The ATD was seated in the WC seat with the torso upright.	Pass
5.1d	Primary load-carrying components of the seating system and attachment hardware shall not completely fail.	No primary load-carrying components completely failed.	Pass
5.1e	Rigid components, fragments, or accessories with mass of 150 g or greater shall not completely detach.	No components detached from the back support.	Pass
5.1f	Seating system components must not have sharp edges with potential for occupant contact.	There were no sharp edges exposed.	Pass
5.1g	The surrogate belt restraint shall not completely fail due to contact with the seating system.	The surrogate belt restraint did not fail.	Pass
5.1h	Average post-test height of ATD H-points shall not be more than 20% lower than the average pretest height.	N/A – A surrogate seat was used.	N/A

Note: SWCF = surrogate wheelchair frame, N/A = not applicable.

**SUMMARY OF APPLICABLE BACK SUPPORT
PERFORMANCE CRITERIA IN ISO 16840-4**

SLED TEST AS 1602

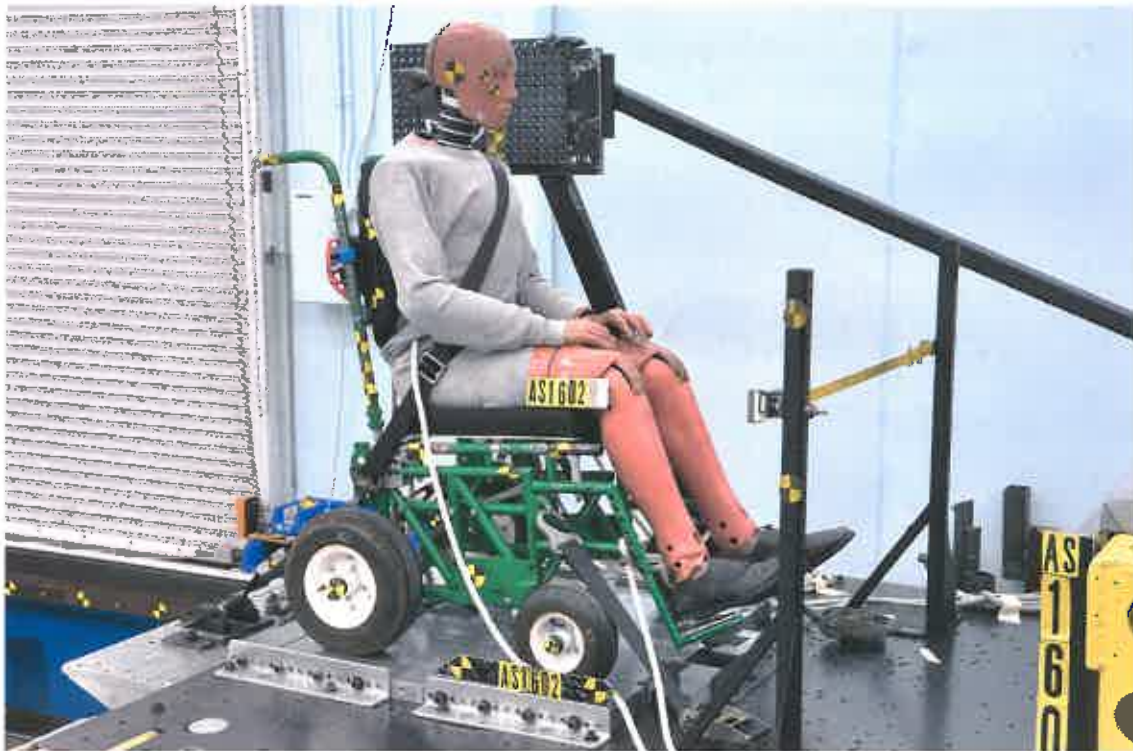
Requirement		Observed Performance	
ISO 16840-4 Clause	Description	Description	Pass/Fail
5.1.2a	Forward excursion of Point P < 200 mm	75 mm	Pass
	Forward knee excursion < 375 mm	243 mm	Pass
	Forward head excursion < 650 mm	336 mm	Pass
	Rearward head excursion < 450 mm	449 mm	Pass
5.1.2c	Seating system shall not separate from the SWCB at any attachment point.	The back support remained attached to SWCB at both attachment points.	Pass
5.1.3a	ATD must be in WC seat with torso leaning not more than 45° from vertical.	The ATD was seated in the WC seat with the torso upright.	Pass
5.1.3b	Primary load-carrying components of the seating system and attachment hardware cannot show visible signs of structural failure.	No primary load-carrying components showed signs of failure.	Pass
5.1.3c	Detached seating hardware cannot exceed 0.1 kg.	No hardware detached from the back support.	Pass
5.1.3d	Rigid seating system components that may contact the occupant shall not have sharp edges with a radius of less than 2 mm.	There were no sharp edges exposed.	Pass
5.1.3e	Post-test height of ATD H-point shall not be more than 20% lower than pretest height	N/A due to use of a surrogate seat assembly.	N/A

Note: SWCB = surrogate wheelchair base, N/A = not applicable.

PRE-TEST PHOTOS



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as160202.JPG



as160203.JPG



as160204.JPG



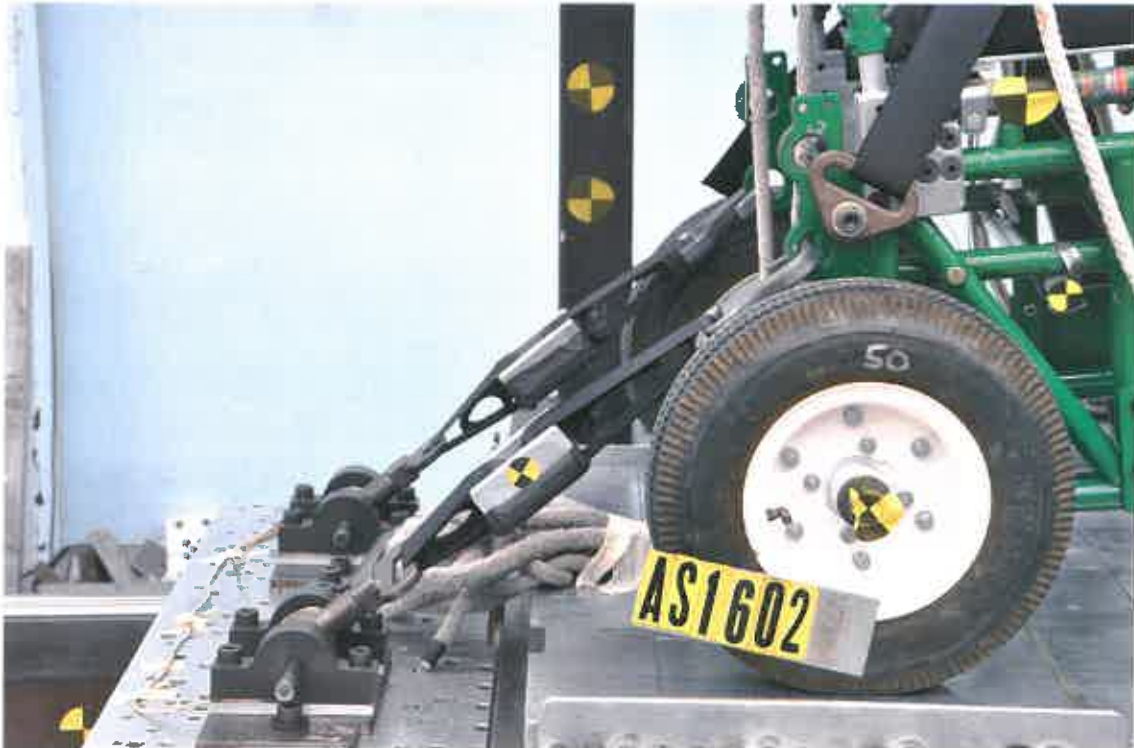
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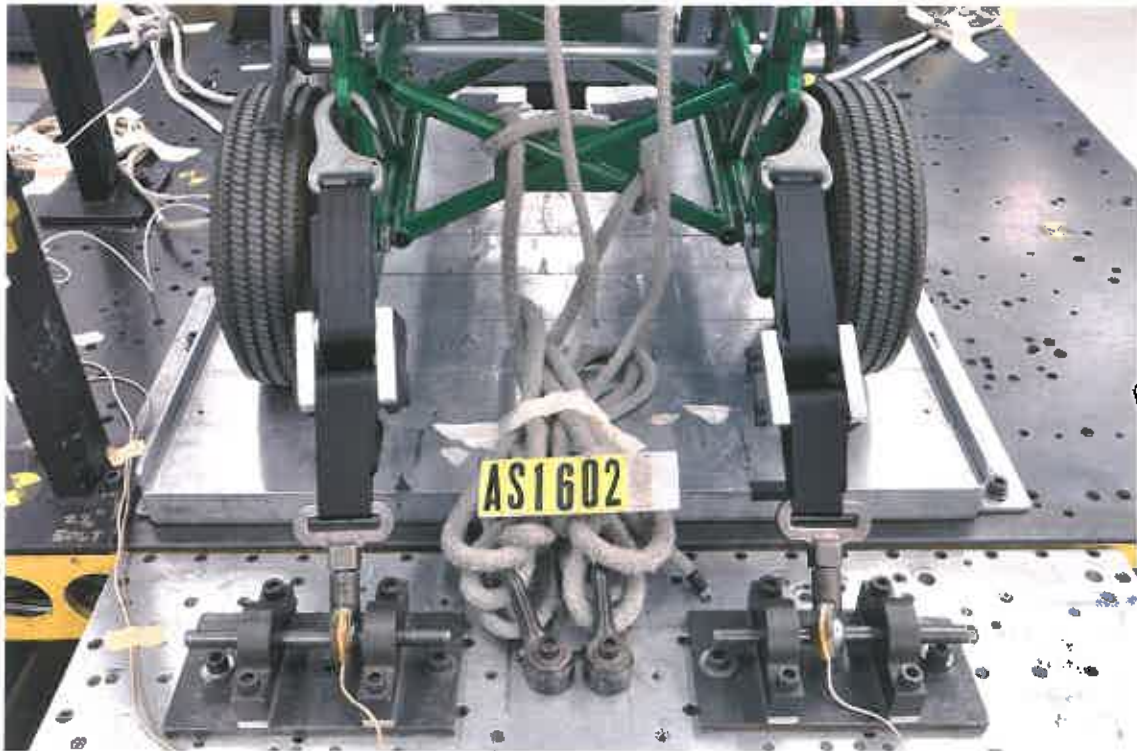
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TEST AND POST-TEST PHOTOS

AS1602

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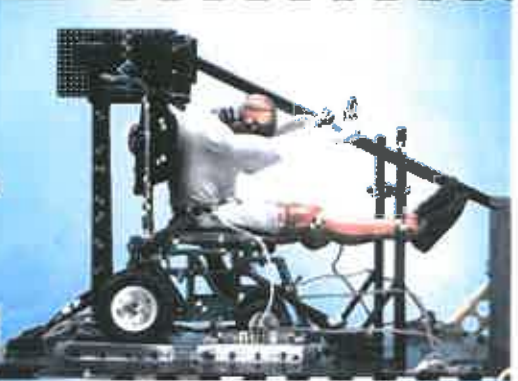
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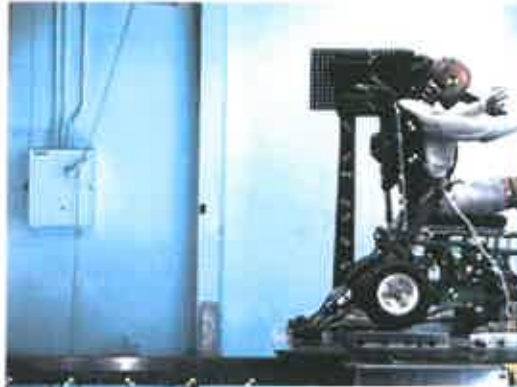


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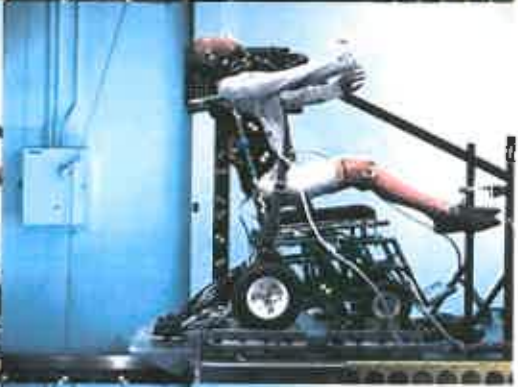
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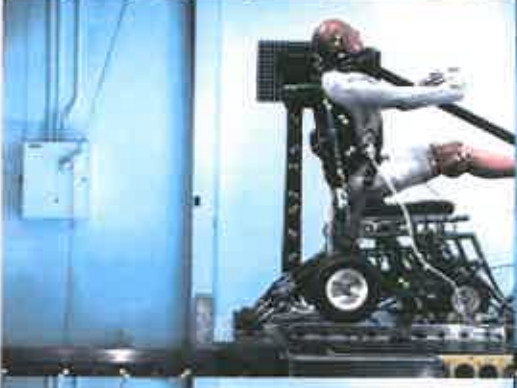
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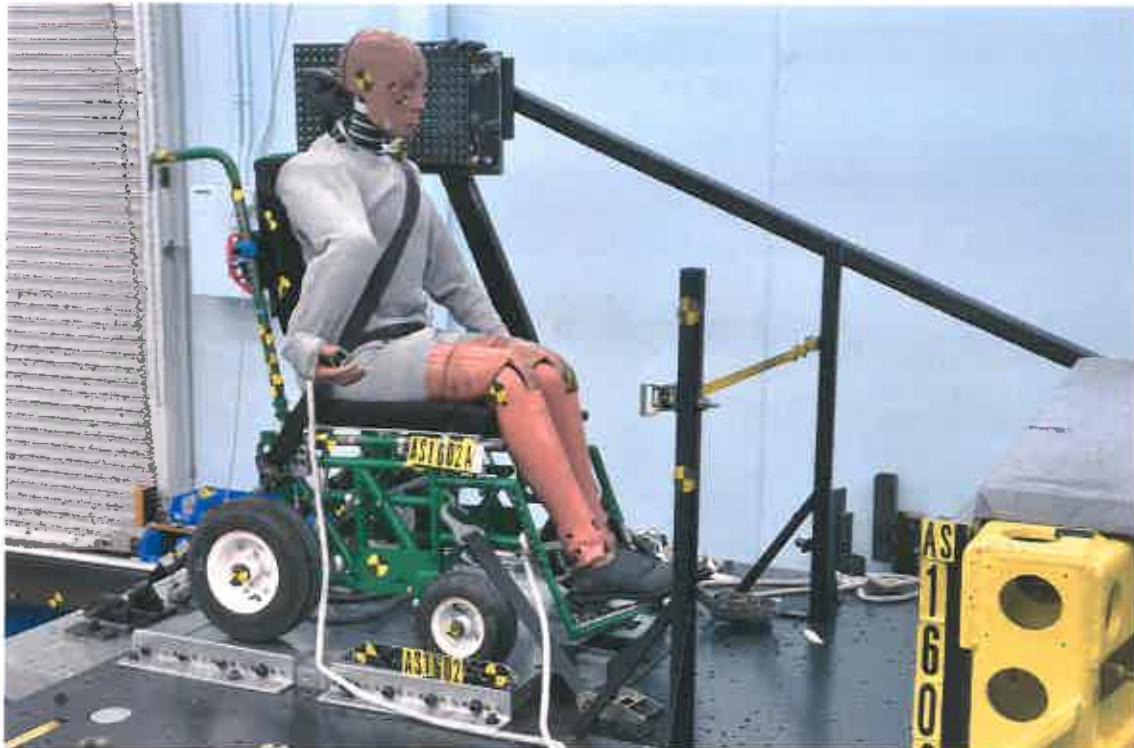


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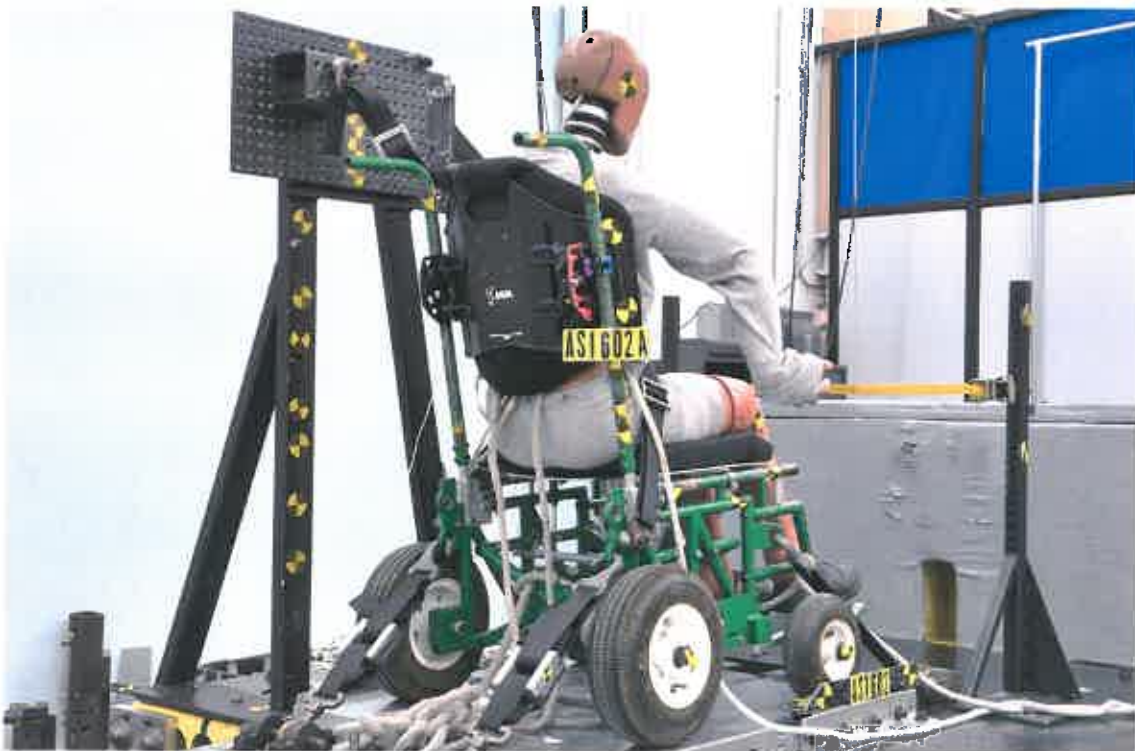
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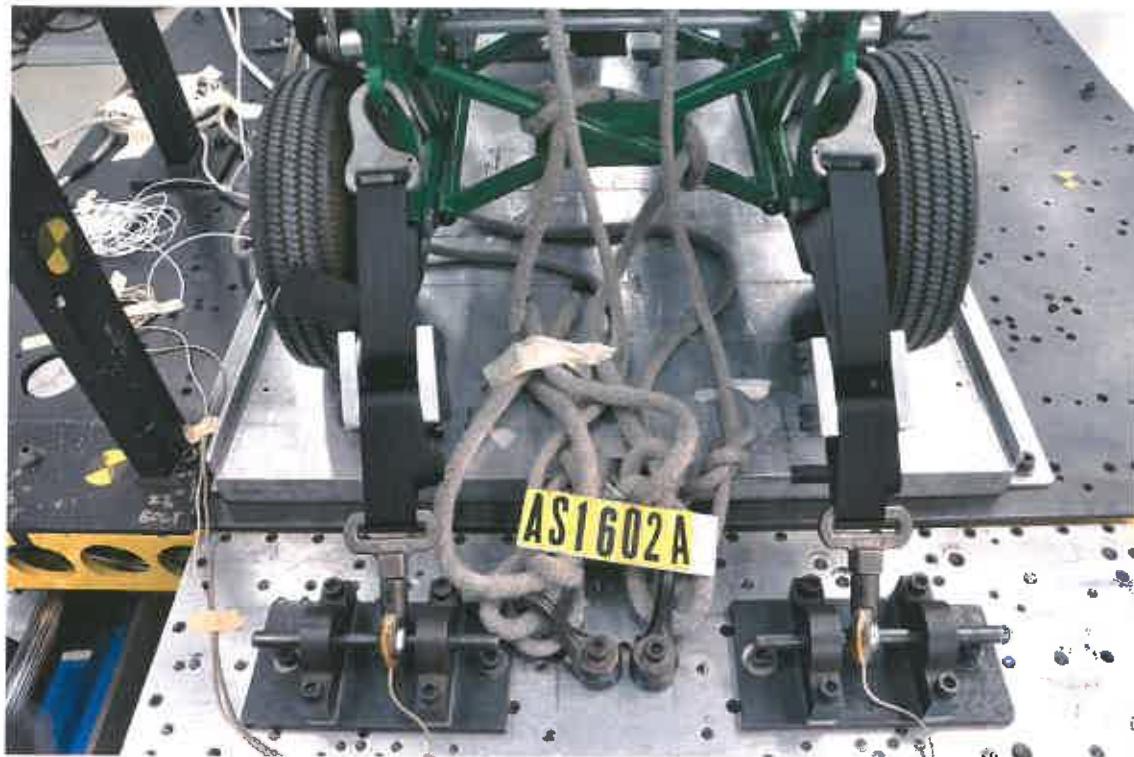
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TEST SIGNALS

Nominal = 30 mph / 20 g Pressures: 140/1050
 Actual[P] = 49.2 km/h (30.6 mph) (75.7%) Plateau Avg. = -21.2 G; Peak = -28.3 G

Dummy: Hybrid III 50th Male (77.7 kg) Buck Weight: 2254
 Buck: Steel plate, extensions, risers, shoulder brace

Aspen/Ride Java Back Support
 with WC-anchored lap and shoulder

Sled Summary

Sled Pulse Duration = 78.6 ms	Efficiency = $V_{out} / V_{in} = 21.2 / 28.0 = 75.7\%$
Sled Plateau Average Level = -21.2 G	Sled Delta V = 49.2 kph (30.6 mph)
Sled Decel Peak = -28.3 G	Stopping Dist. (est) = .574 m
Total time under -20.0 G was 29.6 ms	
Continuous time under -15.0 G was 71.0 ms	

Head Acceleration

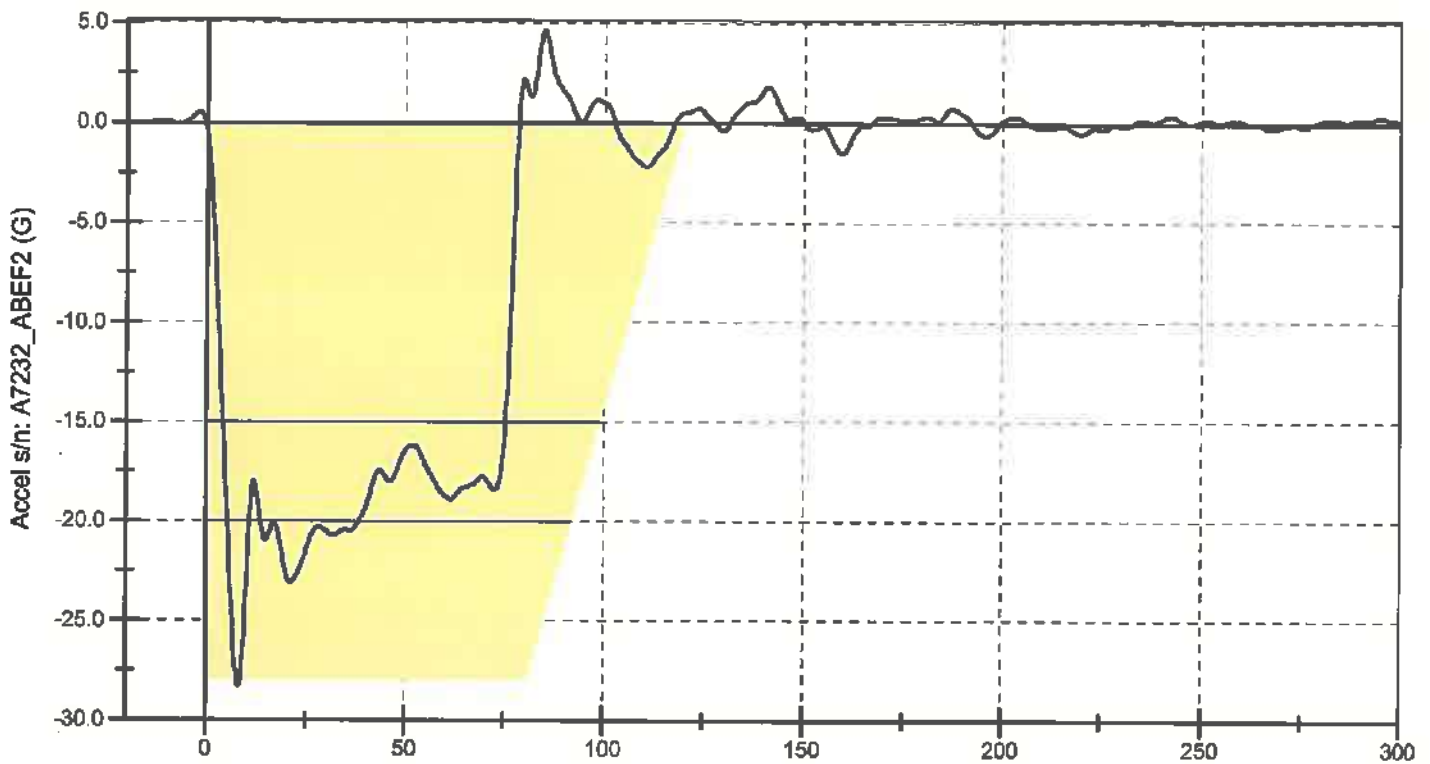
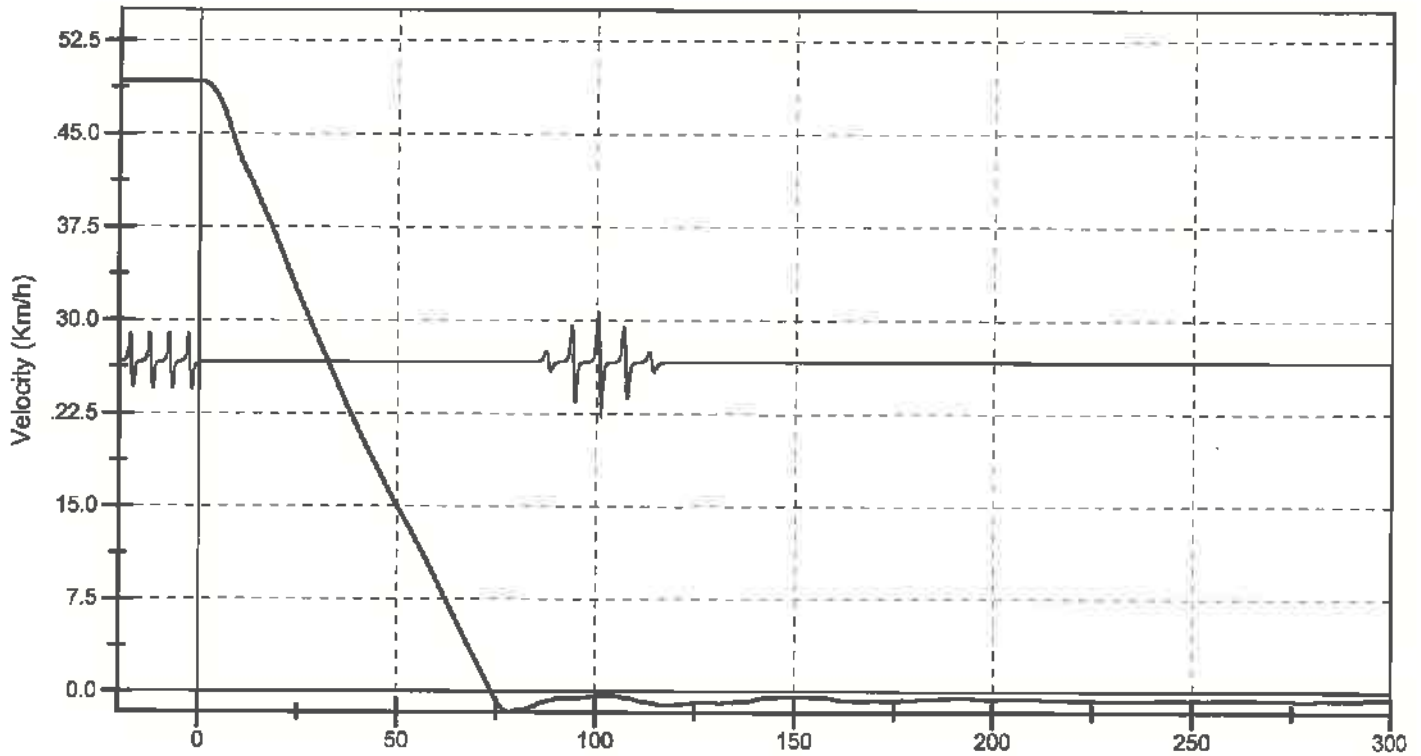
X	-4.6 g @ 242 ms	34.9 g @ 108 ms
Y	-10.8 g @ 60 ms	19.2 g @ 96 ms
Z	-7.7 g @ 13 ms	43.9 g @ 56 ms
Resultant	Peak: 49.2 g @ 56 ms	
H.I.C. (UN) = 590.1	From 39.2 to 124.8 ms	
H.I.C. (36) = 316.8	From 79.5 to 115.5 ms	
H.I.C. (15) = 196.1	From 46.3 to 61.3 ms	

Chest Acceleration

X	-6.3 g @ 169 ms	36.5 g @ 56 ms
Y	-19.9 g @ 81 ms	20.1 g @ 47 ms
Z	-2.9 g @ 192 ms	11.0 g @ 89 ms
Resultant	Peak: 41.3 g @ 56 ms	
3.0 ms Clipped Peak = 39.4G	From: 54.5 to 57.5 ms	
Total time over 60 G was 0.0 ms		

Belt Loads

Lap Belt Load	-4.3 N (-1.0 lb) @ 10 ms	9578.2 N (2153.3 lb) @ 64 ms
Shoulder Belt Load	-9.9 N (-2.2 lb) @ 298 ms	10643.8 N (2392.8 lb) @ 59 ms
Left Rear Tiedown Load	-1305.8 N (-293.5 lb) @ 113 ms	16067.1 N (3612.0 lb) @ 58 ms
Right Rear Tiedown ...	-690.5 N (-155.2 lb) @ 266 ms	20304.7 N (4564.7 lb) @ 59 ms



Continuous time under -15.0 G was 71.0 ms

Total time under -20.0 G was 29.6 ms

Sled Decel Peak = -28.3 G

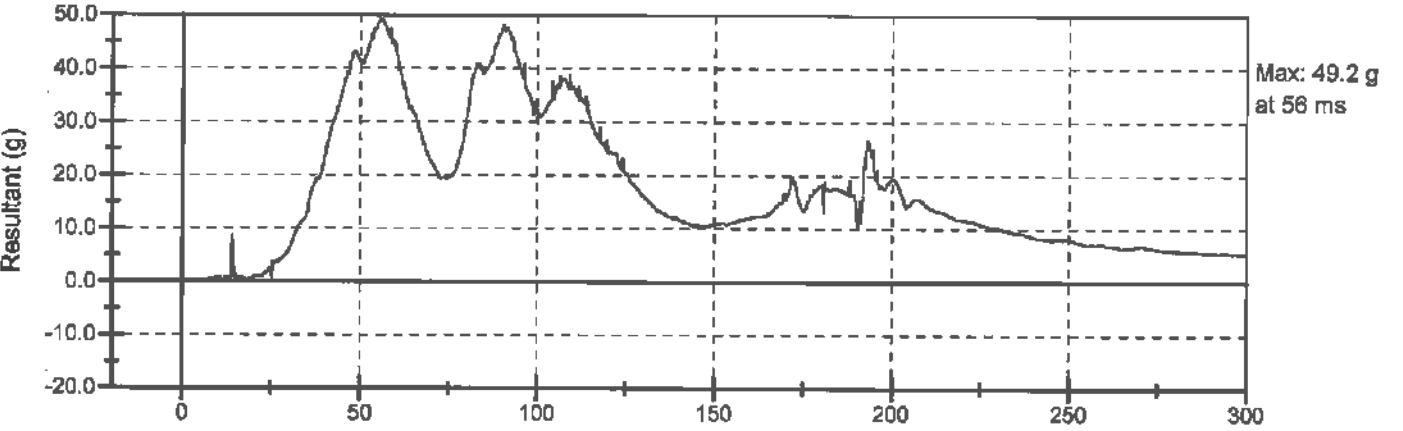
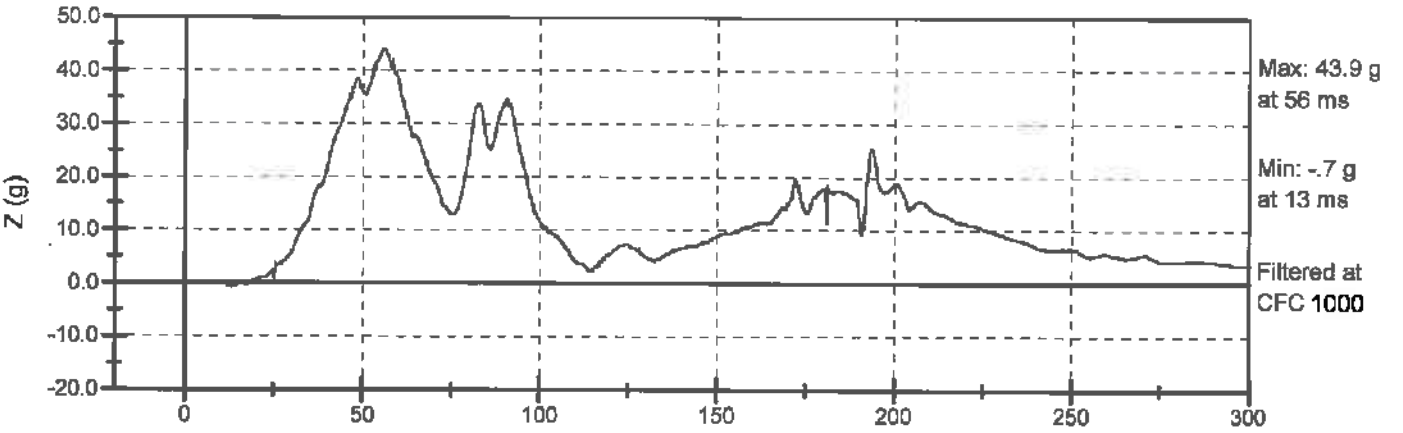
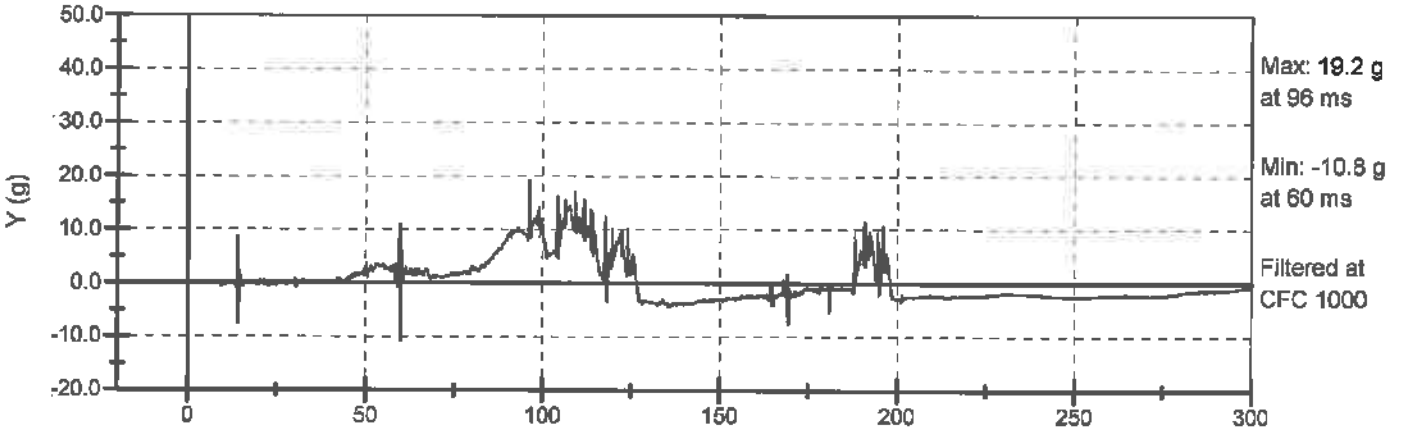
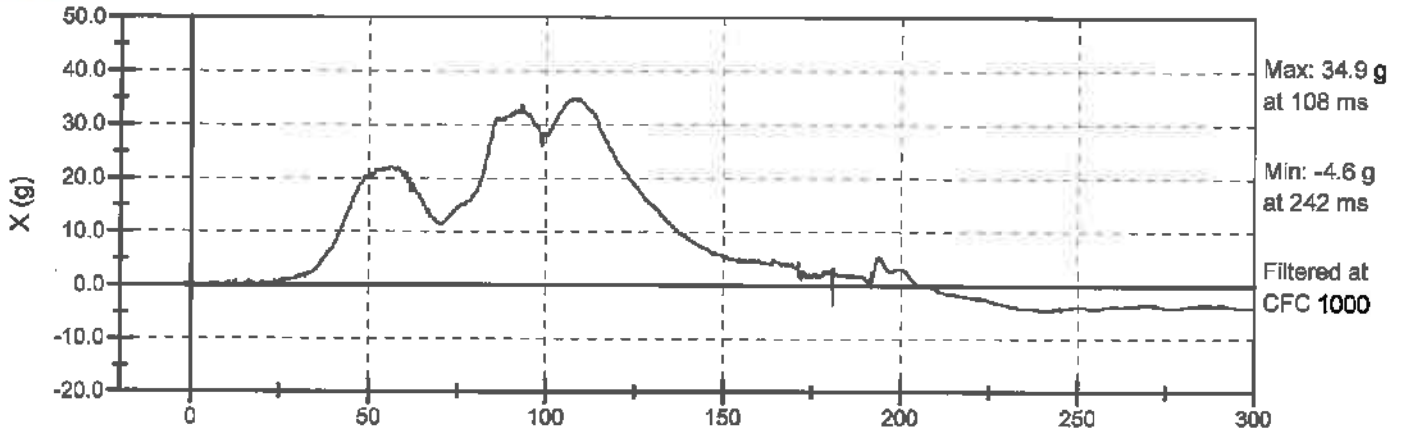
Sled Plateau Average Level = -21.2 G

Sled Pulse Duration = 78.6 ms

Stopping Dist. (est) = .574 m

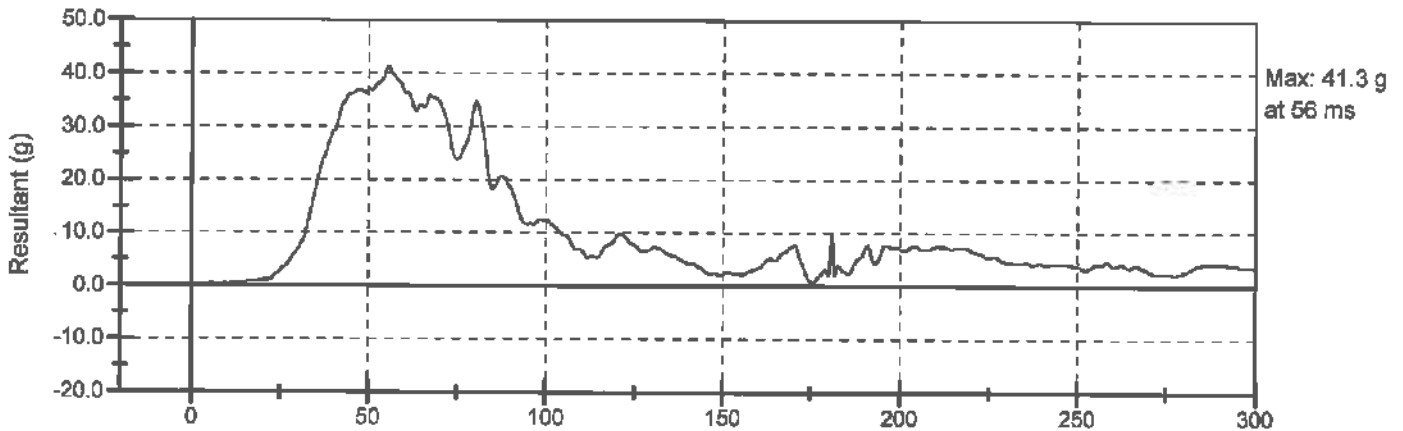
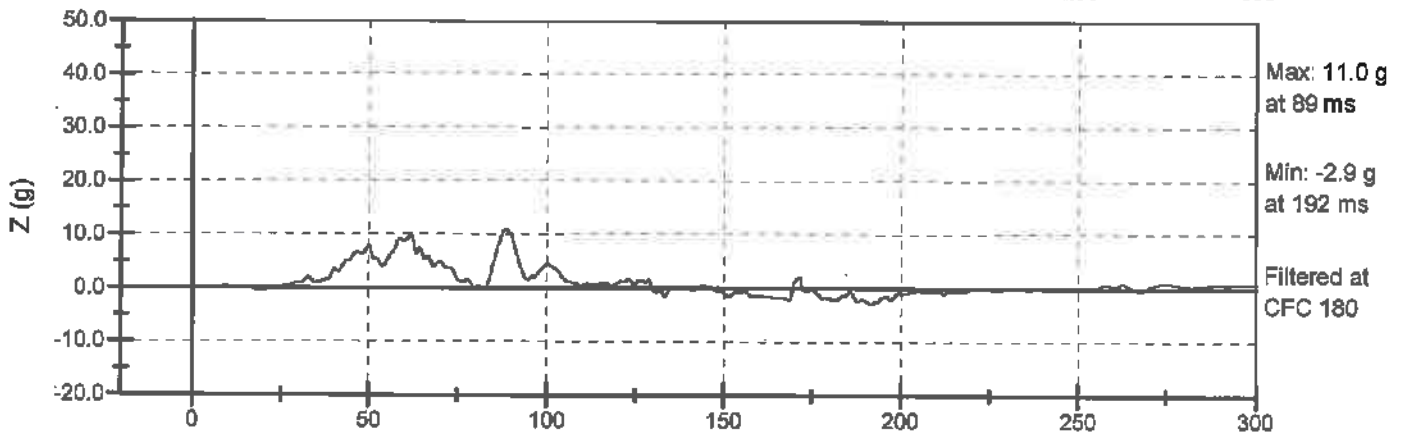
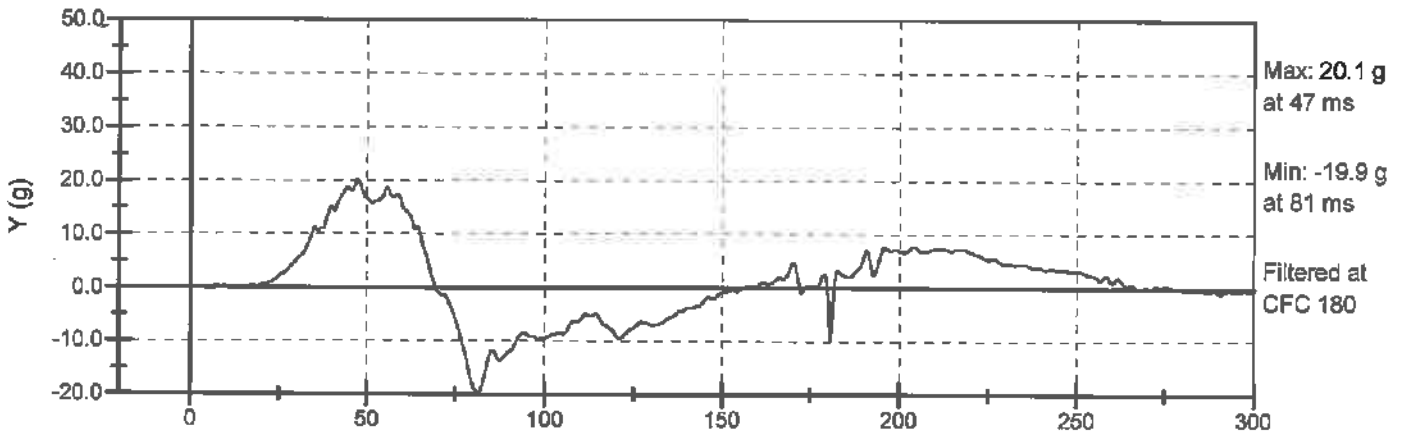
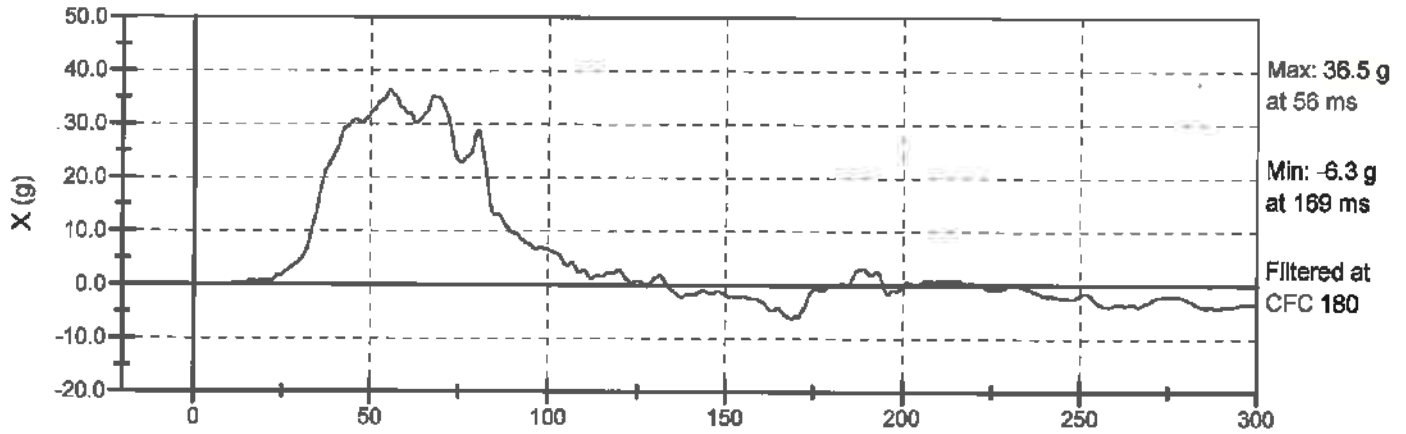
Sled Delta V = 49.2 kph (30.6 mph)

Efficiency = $V_{out} / V_{in} = 21.2 / 28.0 = 75.7\%$



H.I.C. (15) = 196.1
H.I.C. (36) = 316.8
H.I.C. (UN) = 590.1

From: 46.3 to 61.3 ms
From: 79.5 to 115.5 ms
From: 39.2 to 124.8 ms



Total time over 60 G was 0.0 ms
3.0 ms Clipped Peak = 39.4G

From: 54.5 to 57.5 ms

