

Sled Impact Test

HG 1105
Hoggi, GmbH

**Frontal Impact of a Hoggi Bingo Evolution Wheelchair
Secured by a Surrogate Four-Point, Strap-Type Tiedown
and Loaded with a Hybrid III 10-Year-Old ATD Weighted to 90 lb
Restrained by a Surrogate Three-Point Belt with Wheelchair-Anchored Lap Belt**

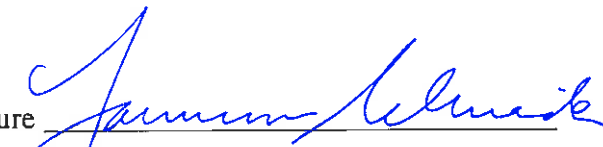
Tested in accordance with Annex A of ANSI/RESNA WC19
Wheelchairs Used as Seats in Motor Vehicles
and ISO 7176-19 *Wheeled Mobility Devices for Use in Motor Vehicles*

Test Date: April 1, 2011

Submitted to:
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ACKNOWLEDGMENT AND DATA USE RESTRICTION

This test was sponsored by Hoggi of Ransbach-Baumbach, Germany, and was conducted in accordance with procedures set forth in Annex A of Section 19, ANSI/RESNA WC/Vol.1 *Wheelchairs Used as Seats in Motor Vehicles*, hereafter referred to as ANSI/RESNA WC19 or WC19, and ISO 7176-19 *Wheeled Mobility Devices for Use in Motor Vehicles*. The wheelchair's performance has been measured and evaluated according to the requirements of 5.3 of WC19 and 5.2 of ISO 7176-19.

Advertisements and marketing literature should refer to the requirements and provisions of ANSI/RESNA WC19 and ISO 7176-19, but should not refer to the University of Michigan, 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 in accordance with Annex A of ANSI/RESNA WC19 and ISO 7176-19. The sled operates on the rebound principle, achieving a desired change in velocity by reversing its direction of motion 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 Hoggi Bingo Evolution wheelchair was placed on the sled platform facing forward, and secured using the surrogate four-point, strap-type tiedown specified in Annex D of WC19. The front and rear tiedown straps were hooked to the securement points provided on the frame of the wheelchair.

The wheelchair was loaded with a Hybrid III 10-year-old anthropomorphic test device (ATD) weighted to 90 lb that was restrained by a surrogate three-point belt with wheelchair-anchored lap belt.* The left end of the surrogate lap belt was attached to a pin-bushing anchorage on the rear securement-point bracket just below and behind the seat/back-support junction on the left side of the wheelchair, while the right side of the surrogate lap belt and the lower portion of the shoulder belt formed a continuous loop through a triangular pin-bushing connector attached to a pin-bushing anchorage on the rear securement-point bracket just below and behind the seat/back-support junction on the right side of the wheelchair. Both sides of the lap belt were routed on the inside of the wheelchair frame and inserted in the gap between the back support and seat cushion before connecting to the pin-bushing anchorages. A three-bar clip held the lap and shoulder belt together near the right hip of the ATD. The upper anchorage of the shoulder belt was bolted to a rigid fixture that simulated the geometry of a typical vehicle sidewall anchor point. The pelvic belt was tightened to fit snugly over the ATD's pelvic region. The shoulder belt was tightened snugly across the ATD's chest with a 75-mm block between the belt and ATD, and the 75-mm 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 frontal-impact response of the wheelchair and compliance with WC19 and ISO 7176-19. The following table provides further details about the test equipment and setup.

*As of May 2002, compliance with WC19 requires testing with a commercial wheelchair-anchored lap belt provided by the wheelchair manufacturer.

SUMMARY OF TEST SETUP AND PRE-TEST MEASUREMENTS

<p>GENERAL TEST INFORMATION</p> <p>Test number Test date Wheelchair type Wheelchair tiedown Occupant restraint Anthropomorphic Test Dummy (ATD) Wheelchair orientation Sled platform Desired impact velocity (ΔV) Desired average sled deceleration</p>	<p>HG 1105 April 1, 2011 Hoggi Bingo Evolution wheelchair Surrogate four-point, strap-type tiedown Surrogate three-point belt with WC-anchored lap belt Hybrid III small female @ 58.6 kg (130 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>1283 mm (50.5 in) 432 mm (17.0 in) 38 degrees 0 degrees 432 mm (17.0 in) 495 mm (19.5 in) 699 mm (27.5 in) 39 degrees 13 degrees 622 mm (24.5 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</p>	<p>305 mm (12.0 in) 178 mm (7.0 in) 1105 mm (43.5 in) 305 mm (12.0 in) 42 degrees 58 degrees, measured on ATD torso 30 degrees, measured above ATD shoulder</p>
<p>FOOTSTRAPS POSITIONING</p> <p>In front of ATD knee center Above ATD knee center</p>	<p>394 mm (15.5 in) 51 mm (2.0 in)</p>
<p>ATD POSITIONING</p> <p>Shoulder height above sled platform H-point height above sled platform</p>	<p>927 mm (36.5 in) 521 mm (20.5 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</p>	<p>15.9 kg (35 lb) 483 mm (19.0 in) 11 degrees 711 mm (28.0 in) 10 degrees 457 mm (18.0 in) 318 mm (12.5 in)</p>
<p>POSTURAL SUPPORT DEVICES USED</p>	<p>Footrests Headrest Lateral thigh supports</p>

TEST RESULTS

The Hoggi Bingo Evolution wheelchair was effectively secured during frontal-impact loading and the ATD was effectively restrained from forward and rearward excursions by the surrogate three-point belt with wheelchair-anchored lap belt and wheelchair back support, respectively. The wheelchair was in an upright position at the completion of the test and the ATD was seated in the wheelchair with the torso leaning approximately 30° to the left. The maximum forward excursion of point P on the wheelchair seating system was 44 mm, which is below the WC19 and ISO 7176-19 excursion limit of 175 mm. After the test, there was no observable deformation of the securement points. The tiedown hooks could be removed from the wheelchair securement points and the ATD could be removed from the belt restraints without the use of tools.

Peak forward excursion of the ATD's head was limited to approximately 324 mm and peak forward knee excursion was limited to about 89 mm, which are below the WC19 and ISO 7176-19 excursion limits of 500 mm and 325 mm, respectively. The ATD's head traveled 233 mm rearward from its initial position during the test, which is below the limit of 400 mm. The ratio of the ATD's knee excursion to the wheelchair point-P excursion is 2.0, which is above the minimum allowed ratio of 1.1. The post-test ATD H-point height decreased by 2% from the pre-test height, which is below the 20% limit in WC19 and ISO 7176-19.

The results of this test show that the Hoggi Bingo Evolution wheelchair with surrogate wheelchair-anchored three-point belt meets all of the requirements for wheelchair dynamic strength specified in 5.3 of Section 19 of ANSI/RESNA WC/Vol.1 and in section 5.2 of ISO 7176-19. The following tables summarize the test results and compliance with Section 19 of ANSI/RESNA WC/Vol.1 and ISO 7176-19.

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	HG 1105 48 kph (30.2 mph) 20.3 ms 22.9 ms 36.9 ms 64.5 ms 80.3 ms
ATD MEASUREMENTS Peak resultant head acceleration Peak resultant chest acceleration Head Injury Criterion (15 ms) Maximum forward head excursion [†] Maximum forward knee excursion ^{††} Maximum rearward head excursion ^{††} Average post-test H-pt ht above sled platform	62 g 63 g 357 324 mm (12.8 in) 89 mm (3.5 in) 233 mm (9.2 in) 508 mm (20.0 in) 2% change
TIEDOWN LOADS Peak left-rear tiedown strap force Peak right-rear tiedown strap force	7082 N (1592 lb) 10195 N (2292 lb)
BELT LOADS AND PELVIC BELT ANGLE Peak left pelvic-belt load Peak shoulder-belt load	3363 N (756 lb) 6690 N (1504 lb)
WHEELCHAIR MEASUREMENTS^{††} Maximum forward wheelchair excursion at Point P* Maximum forward excursion of front-wheel hub Maximum forward excursion of rear-wheel hub	44 mm (1.7 in) 18 mm (0.7 in) 24 mm (1.0 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.

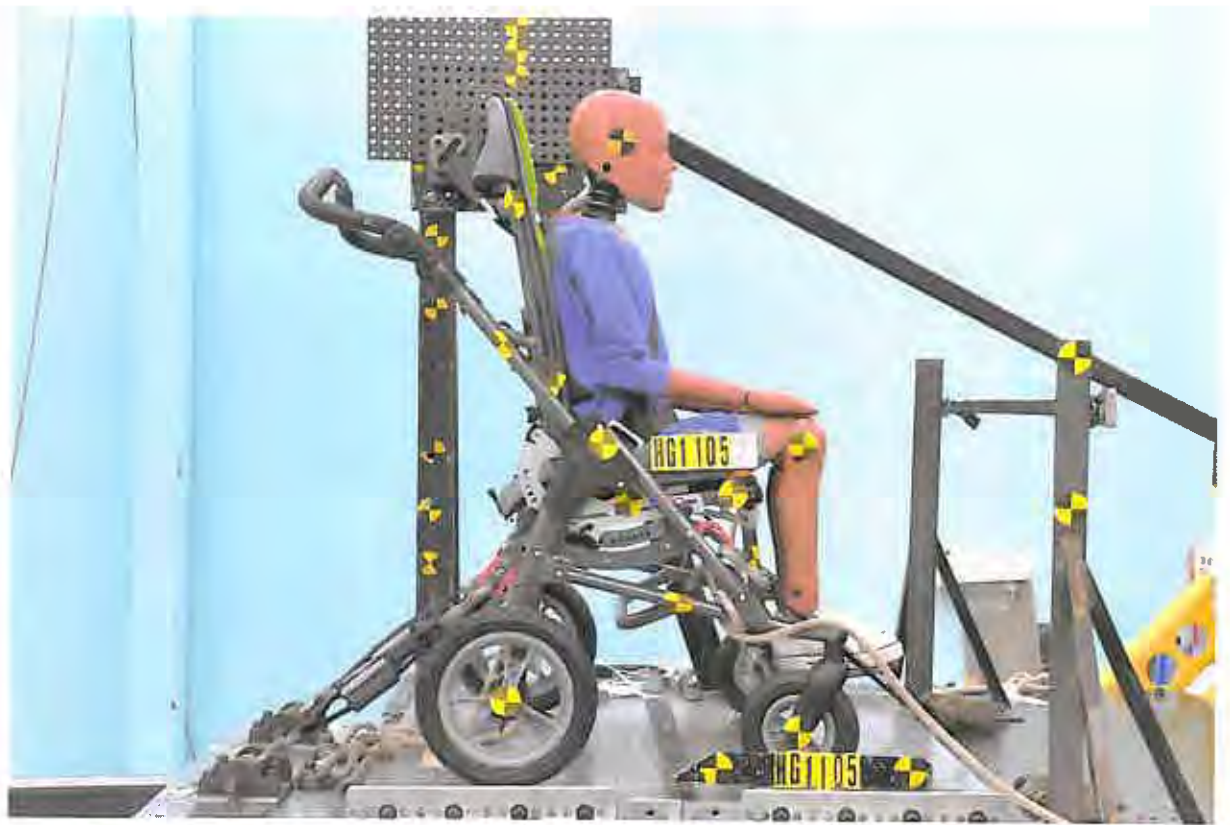
**SUMMARY OF WHEELCHAIR PERFORMANCE TO WC19 AND ISO 7176-19
SLED TEST HG 1105**

Requirement		Observed Performance	
WC19 (ISO 7176-19) Clause	Description	Description	Pass/Fail
5.3a (5.2.2b)	WC securement points cannot show signs of material failure, other than deformation or yielding	No signs of failure	Pass
5.3b	Deformation of WC securement points must not prevent disengagement of hook	Little or no deformation observed; no problem with disengagement	Pass
5.3c (5.2.2a)	WC upright and on test platform	WC was upright on sled platform	Pass
5.3d (5.2.2a)	ATD must be in WC seat with torso reclined not more than 45°	ATD remained in WC seat with torso leaning 30° to the left	Pass
5.3e (5.2.2c)	Detached hardware cannot exceed 100g	No hardware detached with mass exceeding 100 g	Pass
5.3f (5.2.2d)	WC must not have sharp edges with potential for occupant contact	No sharp edges near occupant	Pass
5.3g (5.2.2e)	Primary WC components cannot show visible signs of structural failure that is not anticipated by WC design	No primary load-carrying components failed	Pass
5.3h (5.2.1a)	Forward excursion of Point P<175 mm	44 mm	Pass
	Forward knee excursion <325 mm	89 mm	Pass
	Forward head excursion <500 mm	324 mm	Pass
	Rearward head excursion <400 mm	233 mm	Pass
5.3i (5.2.1b)	Ratio of ATD knee excursion to Point P excursion must exceed 1.1.	Ratio of knee to P-point excursion was 2.0	Pass
5.3j (5.2.2i)	Post-test height of ATD H-point shall not be more than 20% lower than pretest height	H-point height decreased by 2%	Pass
(5.2.2f)	Locking mechanisms of tilting seating adjusters shall not show signs of failure	Seat tilt locking mechanism did not fail	Pass
5.3k	Detachable seating inserts must stay secured to WC at all attachment points	Seat remained attached to WC base frame at all attachment points	Pass
5.3li (5.2.1c)	Batteries must be within WC footprint	N/A	N/A
5.3lii (5.2.1c)	Batteries must remain attached to battery compartment	N/A	N/A
5.3liii (5.2.1c)	Batteries cannot move into the WC user's space.	N/A	N/A
5.3 m (5.2.2j)	WC cannot cause failure of the surrogate WTORS.	No WTORS failure	Pass

Note: WC = wheelchair , N/A = not applicable

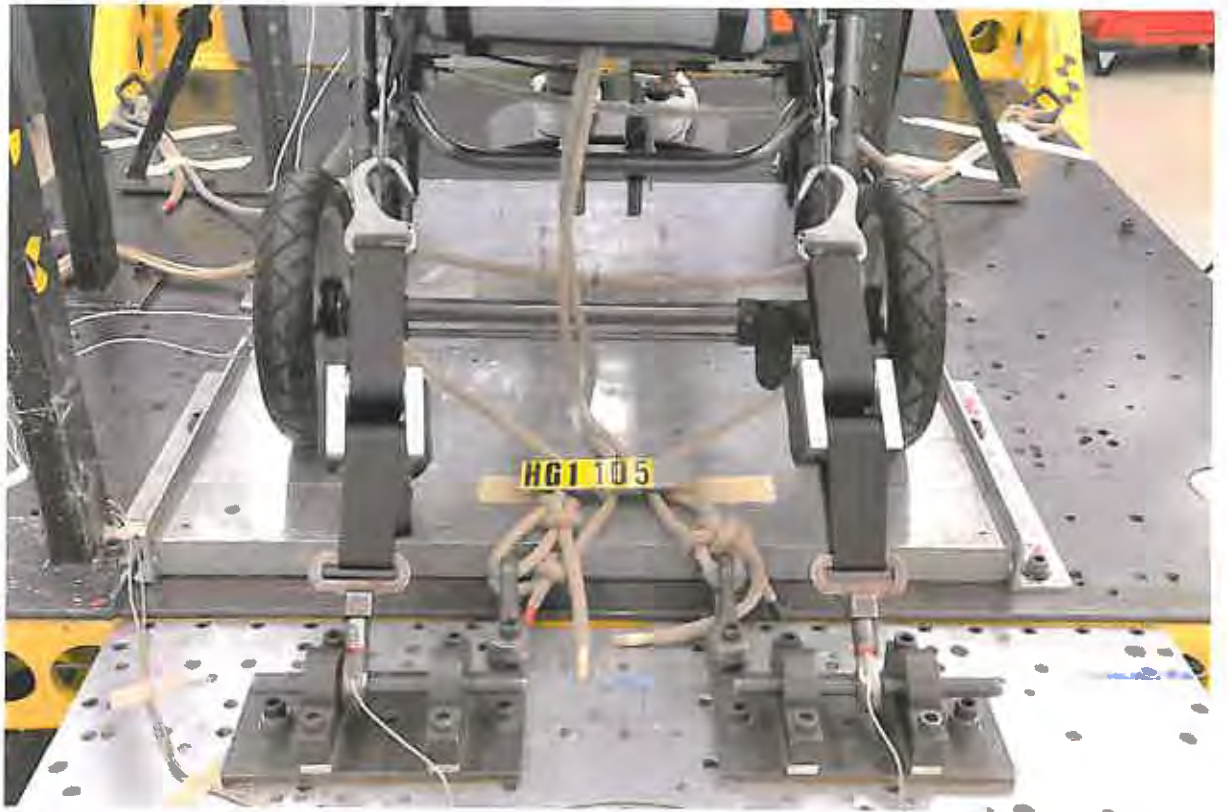
PRE-TEST PHOTOS

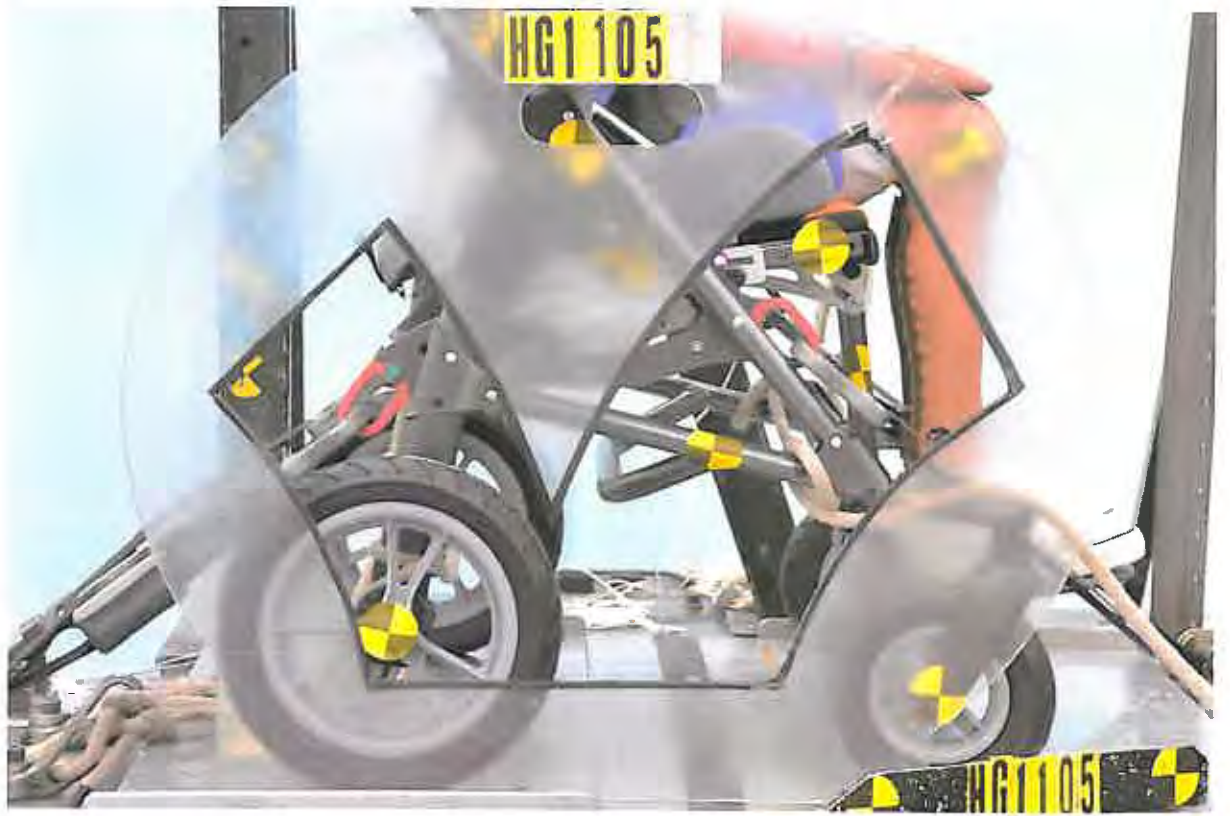








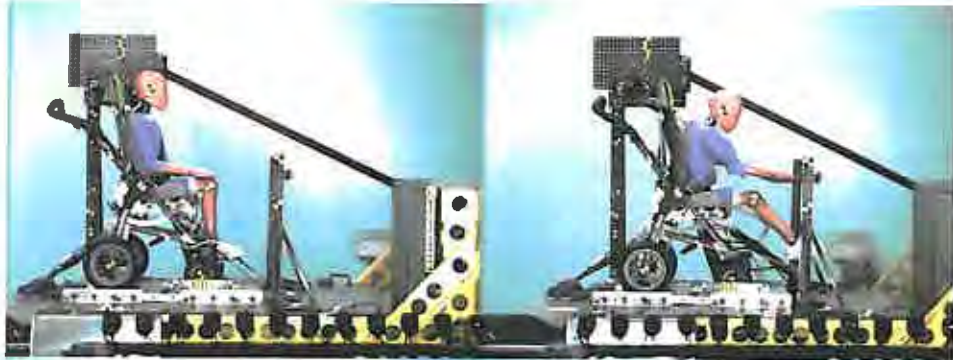




TEST AND POST-TEST PHOTOS

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HG1105

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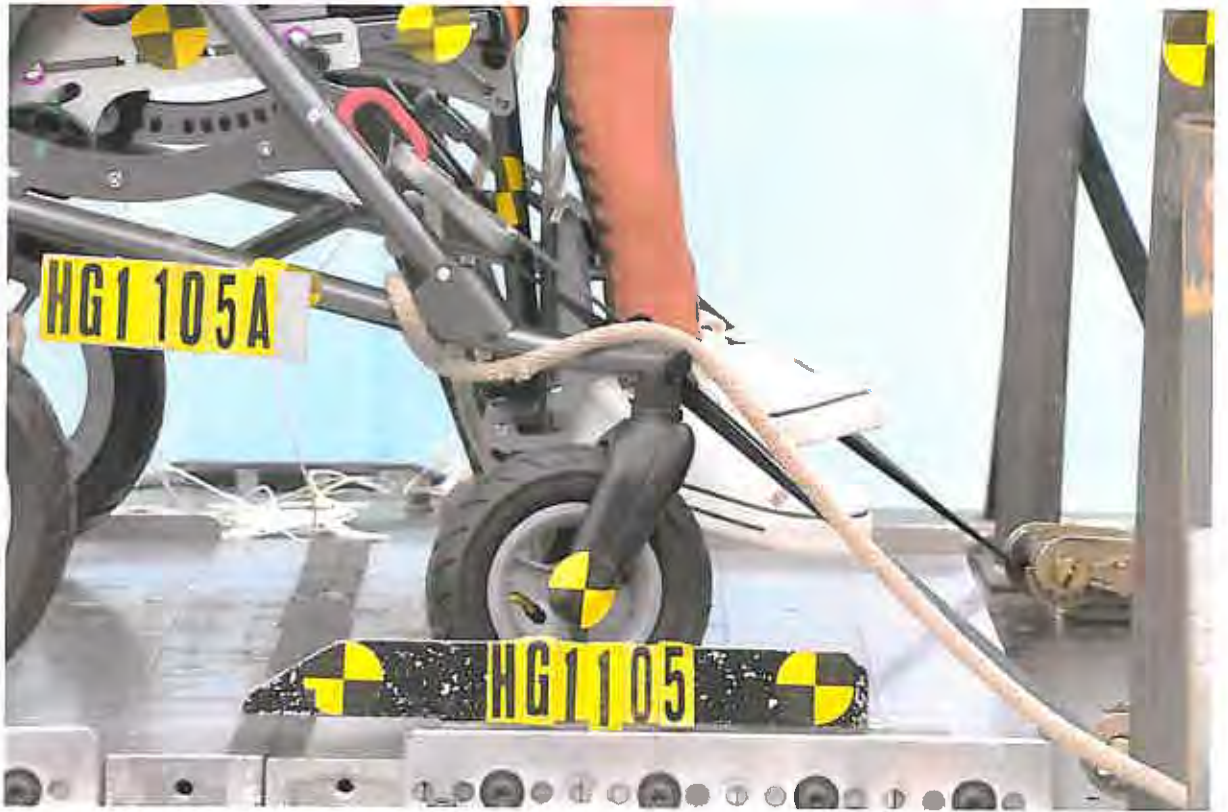
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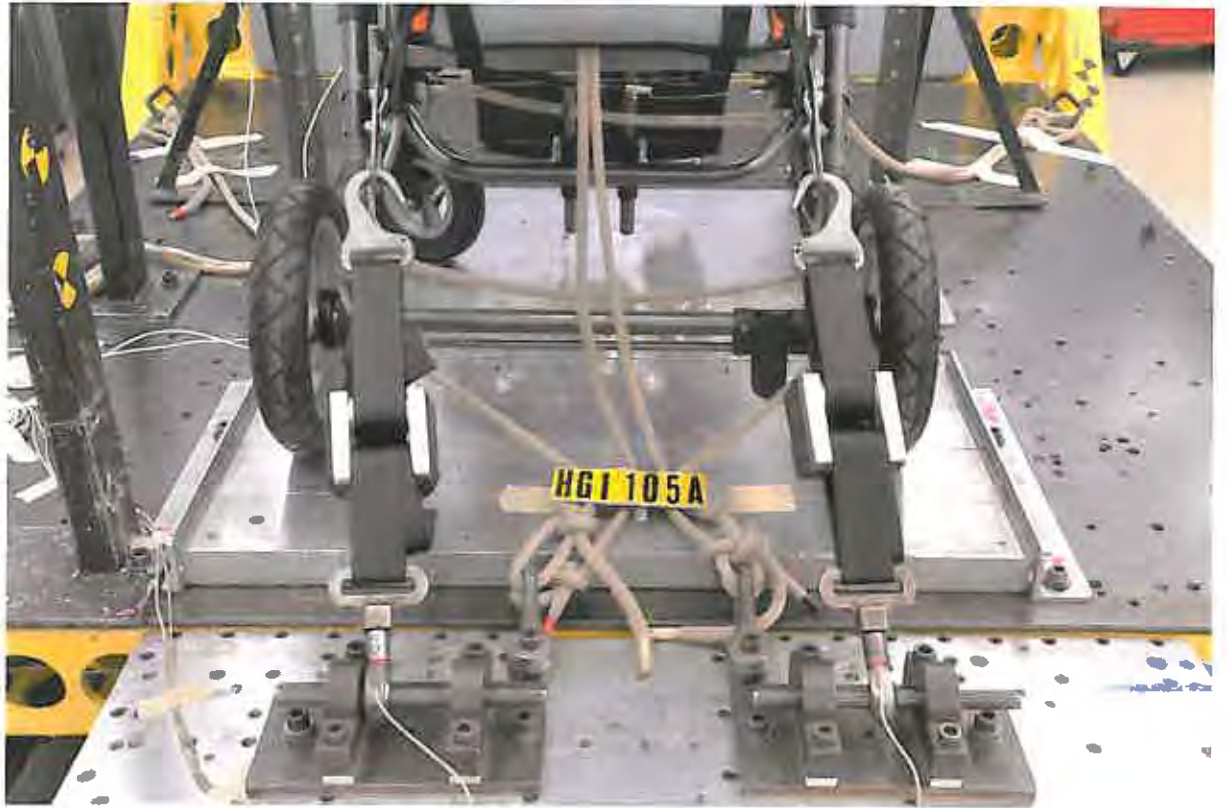
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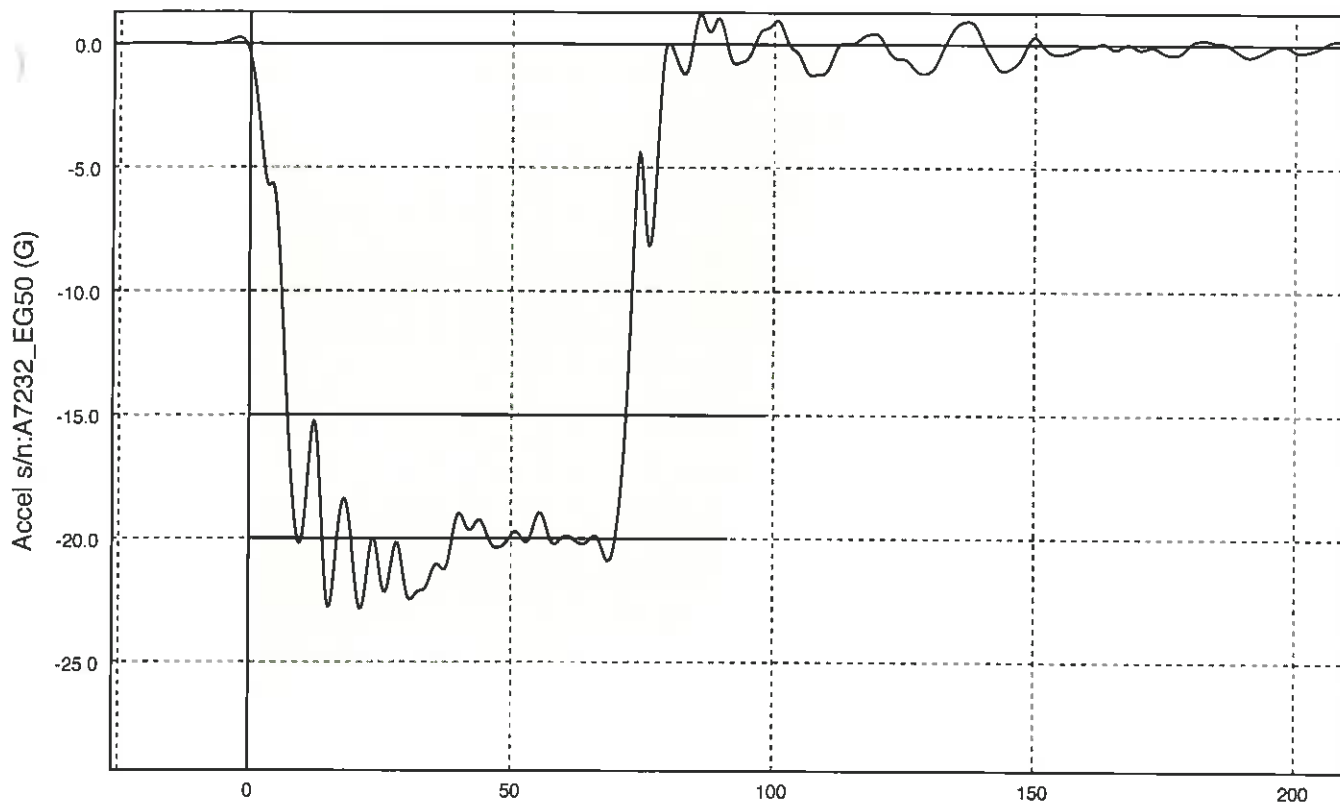
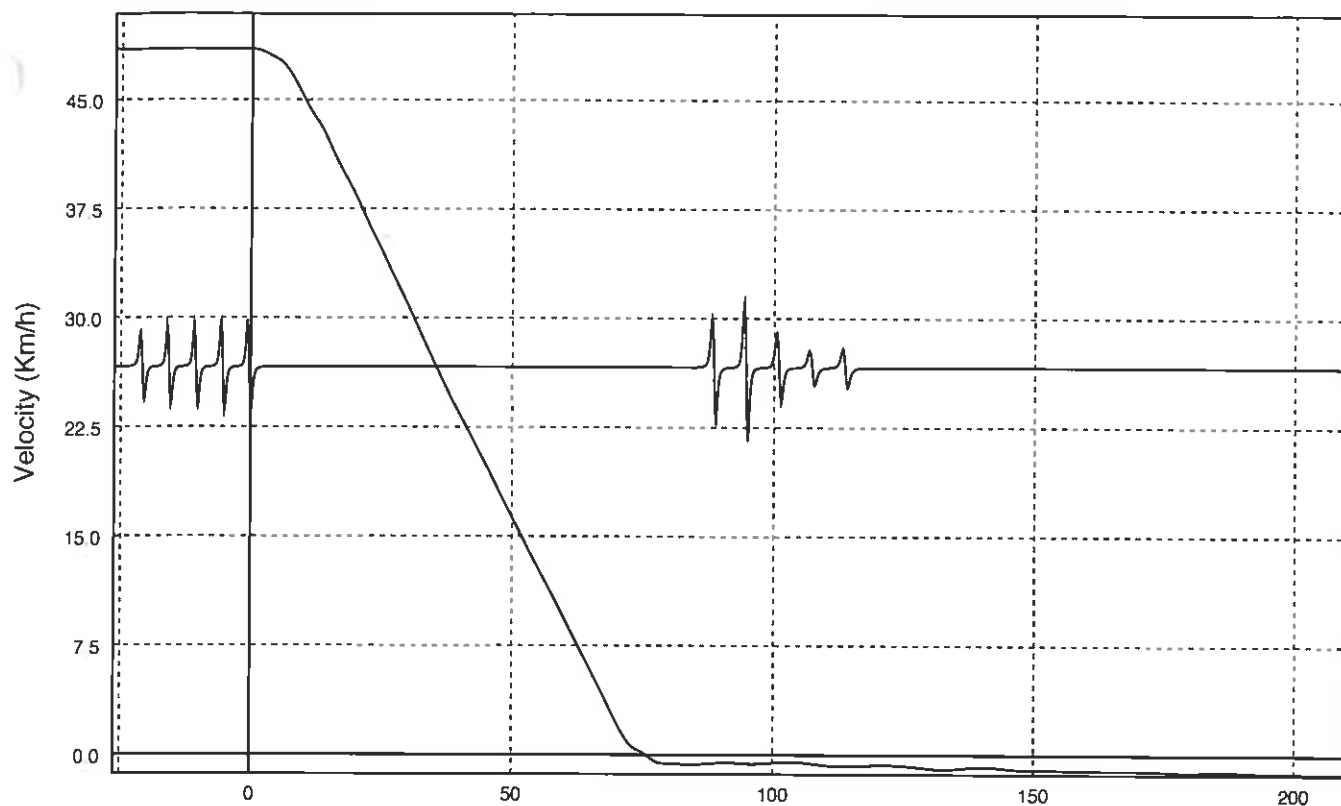








TEST SIGNALS



Continuous time under -15.0 G was 64.5 ms

Total time under -20.0 G was 36.9 ms

Sled Decel Peak = -22.9 G

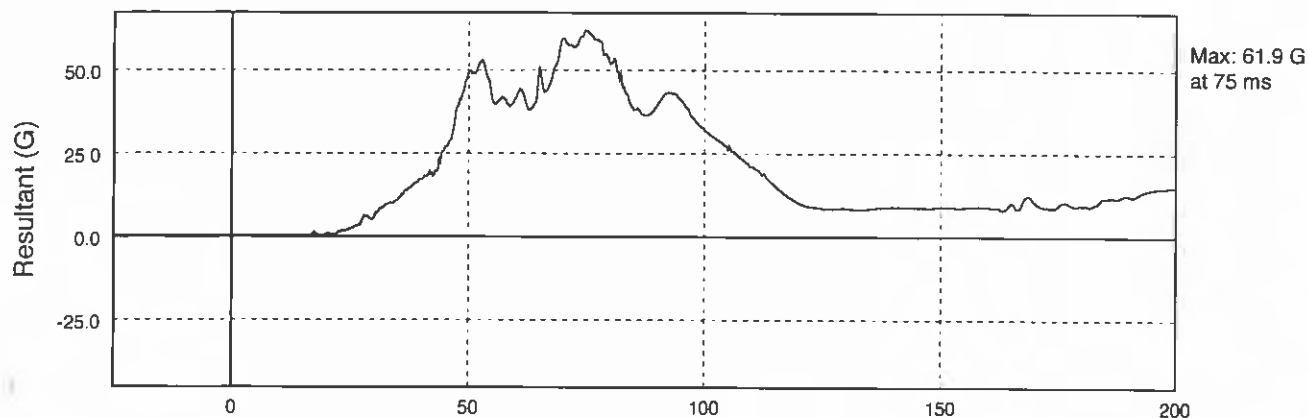
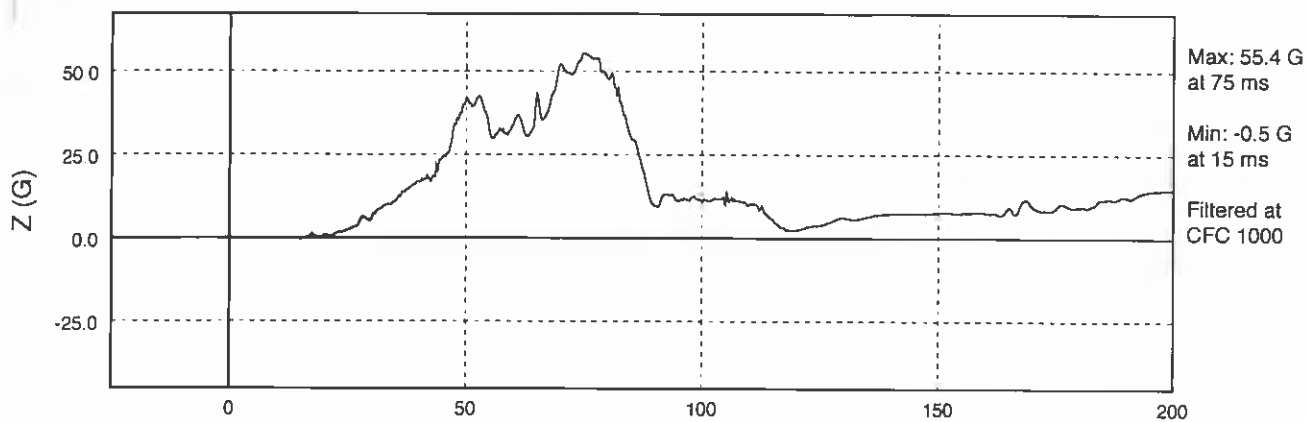
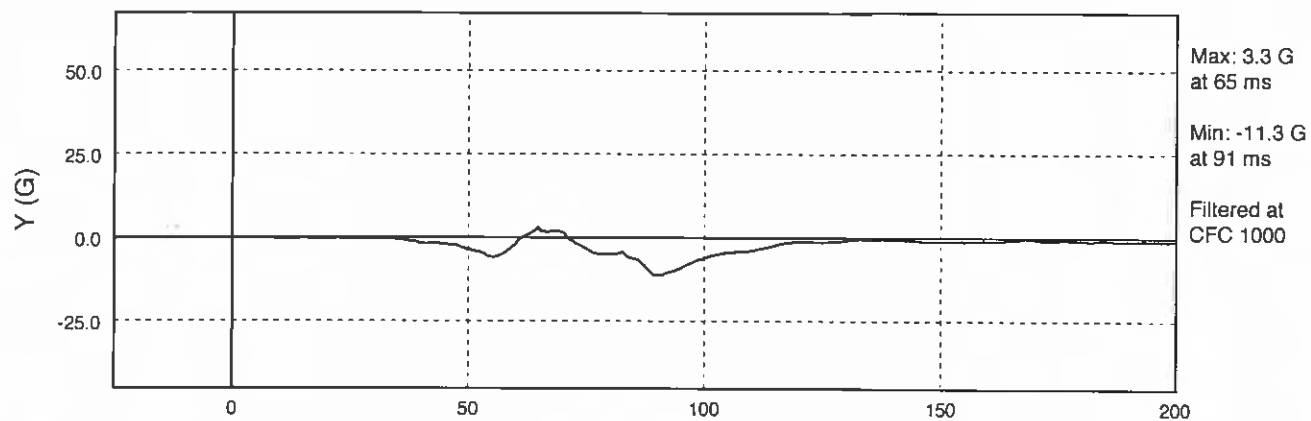
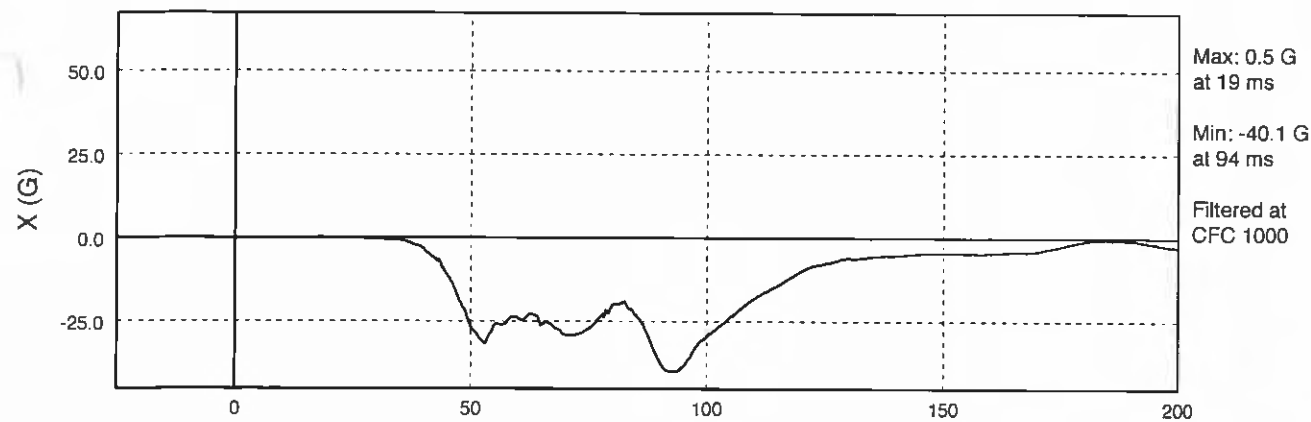
Sled Plateau Average Level = -20.3 G

Sled Pulse Duration = 80.3 ms

Stopping Dist. (est) = 0.545 m

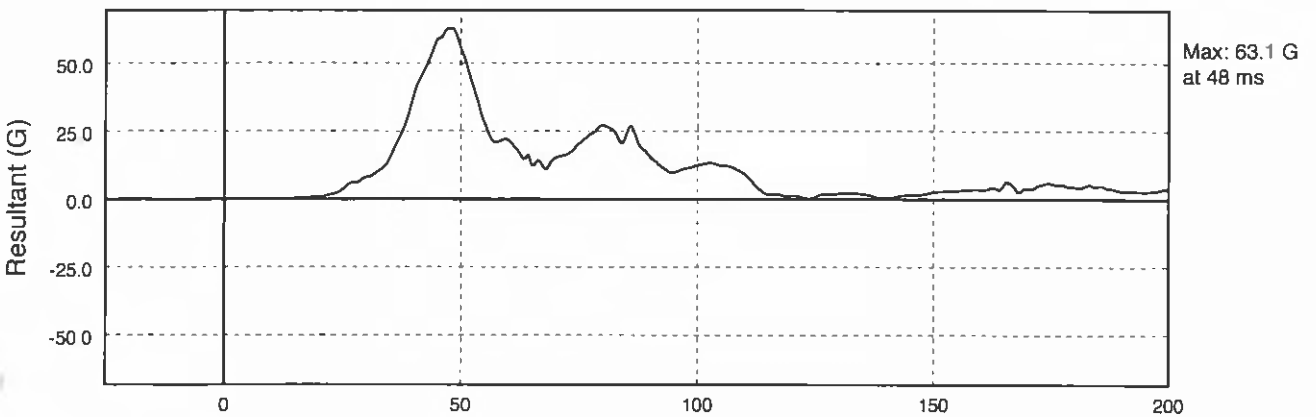
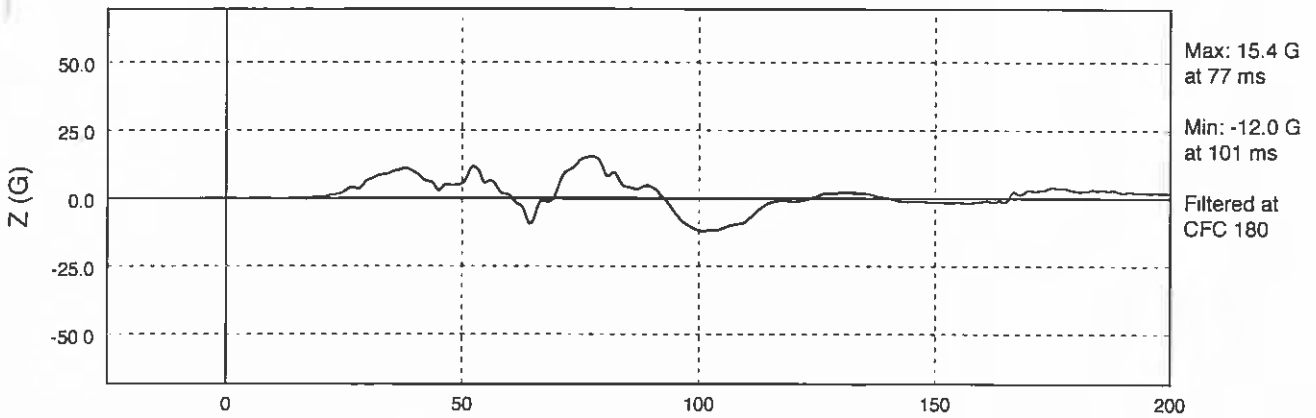
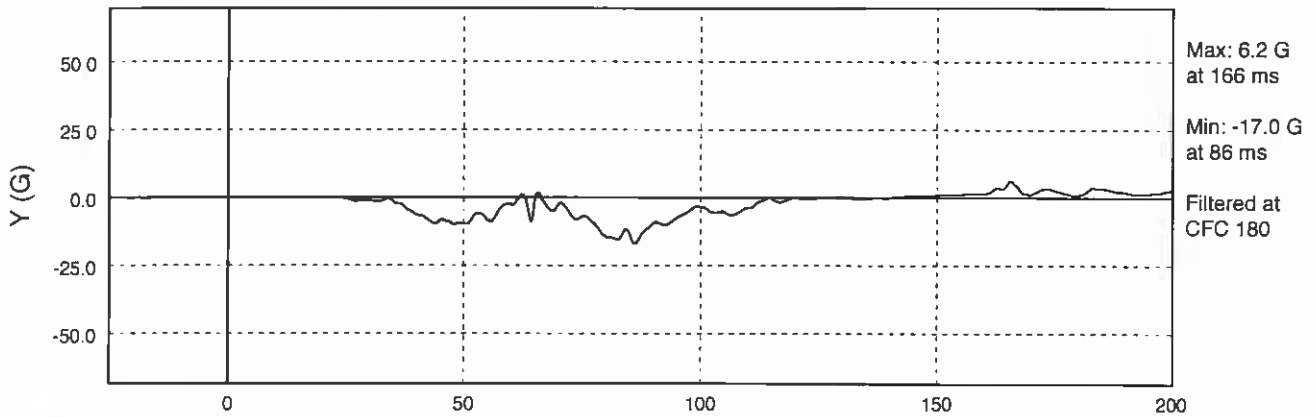
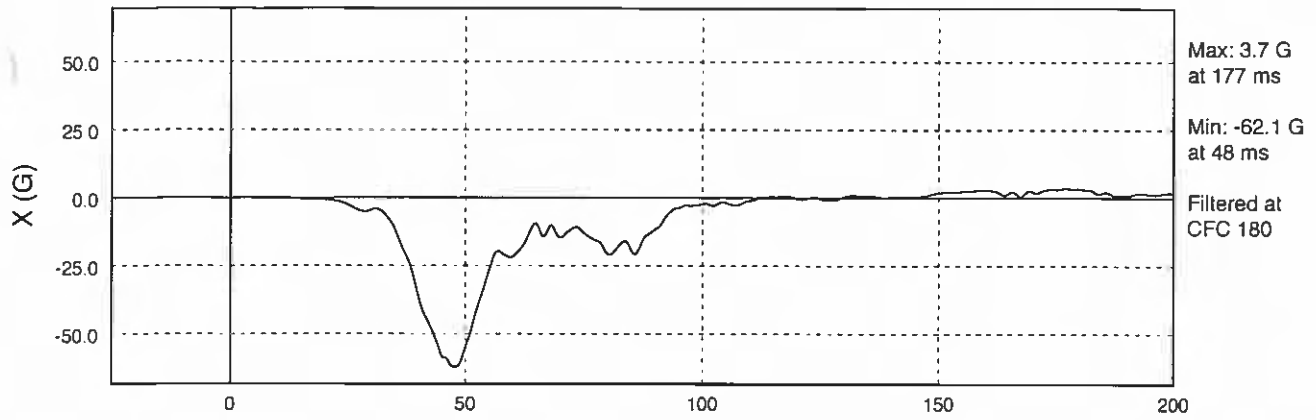
Sled Delta V = 48.7 kph (30.2 mph)

Efficiency = $V_{out} / V_{in} = 22.04 / 26.64 = 82.7\%$



H.I.C. (15) = 356.8
H.I.C. (UN) = 768.3

From: 67.3 to 82.3 ms
From: 44.9 to 105.5 ms



Total time over 60.0 G was 3.0 ms
3.0 ms Clipped Peak = 60.0G

From: 46.1 to 49.1 ms

