

Sled Impact Test

PR 0707

Product Design Group, Inc.

**Frontal Impact of PDG Fuze Wheelchair
Secured by a Surrogate Four-Point, Strap-Type Tiedown and
Loaded with a Midsize Male ATD
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

Test Date: May 30, 2007

Submitted to:
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ACKNOWLEDGMENT AND DATA USE RESTRICTION

This test was sponsored by Product Design Group, Inc. of Vancouver, British Columbia 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. The wheelchair's performance has been measured and evaluated according to the requirements of 5.3 of this standard. Advertisements and marketing literature should refer to the requirements and provisions of ANSI/ RESNA WC19, 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. 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 PDG Fuze 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 tilt-in-space seat rails of the wheelchair.

The wheelchair was loaded with a Hybrid II midsize male anthropomorphic test device (ATD) that was restrained by a surrogate three-point belt with a wheelchair-anchored lap belt. The left end of the lap belt was anchored to the a pin-bushing connector on the inside of the aluminum plate at the seatpan-seatback junction on the left side of the wheelchair, while the right side of the lap belt and the lower portion of the shoulder belt formed a continuous loop through a triangular pin-bushing connector anchored on the inside of the aluminum plate at the seatpan-seatback junction on the right side of the wheelchair. 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 plate between the belt and ATD, and the 75-mm plate 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. 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 Wheelchair type Wheelchair tiedown Occupant restraint</p> <p>Anthropomorphic Test Dummy (ATD) Wheelchair orientation Sled platform Desired impact velocity (ΔV) Desired average sled deceleration</p>	<p>PR 0707 May 30, 2007 PDG Fuze wheelchair Surrogate four-point, strap-type tiedown Surrogate three-point belt with WC-anchored lap belt</p> <p>Hybrid II midsize-male @ 76.4 kg (168 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)</p> <p>406 mm (16.0 in) 45 degrees 0 degrees 356 mm (14.0 in) 584 mm (23.0 in)</p> <p>711 mm (28.0 in) 37 degrees 14 degrees 673 mm (26.5 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) 1295 mm (51.0 in) 305 mm (12.0 in) 50 degrees</p> <p>54 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>533 mm (21.0 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>1118 mm (44.0 in) 597 mm (23.5 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>36.4 kg (80 lb) 476 mm (18.8 in) 10 degrees 584 mm (23.0 in) 8 degrees 521 mm (20.5 in) 457 mm (18.0 in)</p>
<p>POSTURAL SUPPORT DEVICES USED</p>	<p>Armrests Footrests</p>

TEST RESULTS

The PDG Fuze wheelchair was effectively secured during frontal impact loading. After the test, there was a small crack in the lateral thigh support plate on the right side of the wheelchair where it passed between the right seat rail and the right armrest, but this was not considered to be a failure of a primary load-carrying component. The wheelchair was in an upright position at the completion of the test and the ATD was in the wheelchair seat with the torso upright. The maximum forward excursion of point P on the wheelchair seating system was 123 mm, which is below the WC19 excursion limit of 200 mm. After the test, there was no observable deformation of the wheelchair securement points. The tiedown hooks could be removed from the wheelchair securement points without the use of tools.

The ATD was effectively restrained from forward excursion by the surrogate three-point belt with wheelchair-anchored lap belt. Peak forward head excursion was approximately 494 mm and the peak forward knee excursion was about 289 mm, which are below the WC19 limits of 650 mm and 375 mm, respectively. The ratio of the ATD's knee excursion to the wheelchair point-P excursion is 2.3, which is above the minimum required ratio of 1.1. The ATD's head traveled 163 mm rearward from its initial position during the test, which is below the WC19 limit of 450 mm. The post-test ATD H-point height decreased by 2% from its pre-test height, which is below the WC19 limit of 20%.

The results of this test show that the PDG Fuze wheelchair with surrogate wheelchair-anchored lap belt meets all the requirements for wheelchair dynamic strength specified in 5.3 of Section 19 of ANSI/RESNA WC/Vol.1. The following tables summarize the test results and compliance with Section 19 of ANSI/RESNA WC/Vol.1.

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	PR 0707 48 kph (30.0 mph) 20.2 g 23.7 g 26.4 ms 64.2 ms 80.4 ms
ATD MEASUREMENTS Peak resultant head acceleration Peak resultant chest acceleration Head Injury Criteria (15 ms) Maximum forward head excursion [†] Maximum forward knee excursion ^{††} Maximum rearward head excursion ^{††} Average post-test H-pt ht above sled platform	42 g 33 g 148 494 mm (19.5 in) 289 mm (11.4 in) 163 mm (6.4 in) 584 mm (23.0 in) 2% change
TIEDOWN LOADS Peak left-rear tiedown strap force Peak right-rear tiedown strap force	14501 N (32260 lb) 18069 N (4062 lb)
BELT LOADS AND PELVIC BELT ANGLE Peak left pelvic-belt load Peak shoulder-belt load Post-test pelvic restraint angle	7384 N (1660 lb) 10182 N (2289 lb) 36 degrees
WHEELCHAIR MEASUREMENTS^{††} Maximum forward wheelchair excursion at Point P* Maximum forward excursion of front-wheel hub Maximum forward excursion of rear-wheel hub	123 mm (4.8 in) 51 mm (2.0 in) 86 mm (3.4 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.

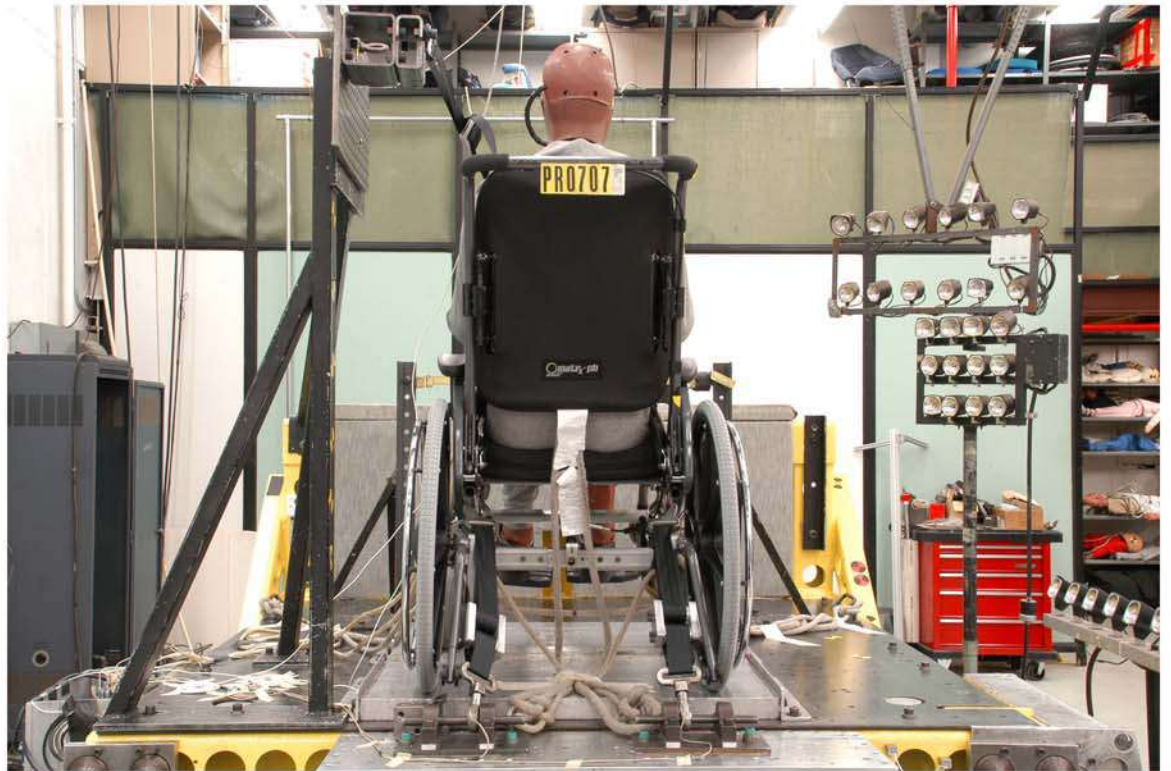
**SUMMARY OF WHEELCHAIR PERFORMANCE TO WC19
SLED TEST PR 0707**

Requirement		Observed Performance	
WC19 Clause	Description	Description	Pass/Fail
5.3a	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	No securement-point deformation was observed	Pass
5.3c	WC upright and on test platform	WC was upright and on sled at the end of the test	Pass
5.3d	ATD must be in WC seat with torso reclined not more than 45°	ATD was in WC seat with torso upright	Pass
5.3e	Detached hardware cannot exceed 100 g	No hardware detached	Pass
5.3f	WC must not have sharp edges with potential for occupant contact	No sharp edges	Pass
5.3g	Primary WC components cannot show visible signs of structural failure that is not anticipated by WC design	No primary WC components failed	Pass
5.3h	Forward excursion of Point P < 200 mm	123 mm	Pass
	Forward knee excursion < 375 mm	289 mm	Pass
	Forward head excursion < 650 mm	494 mm	Pass
	Rearward head excursion < 450 mm	163 mm	Pass
5.3i	Ratio of ATD knee excursion to Point P excursion must exceed 1.1.	Ratio of ATD knee excursion to Point P excursion = 2.3	Pass
5.3j	Post-test height of ATD H-point shall not be more than 20% lower than pretest height	H-point height decreased by 2%	Pass
5.3k	Detachable seating inserts must stay secured to WC at all attachment points	The seating system remained attached at all attachment points	Pass
5.3li	Batteries must be within WC footprint	N/A	N/A
5.3.lii	Batteries must remain attached to battery compartment	N/A	N/A
5.3.liiii	Batteries cannot move into the WC user's space.	N/A	N/A
5.3 m	WC cannot cause failure of the surrogate WTORS.	No surrogate WTORS failure	Pass

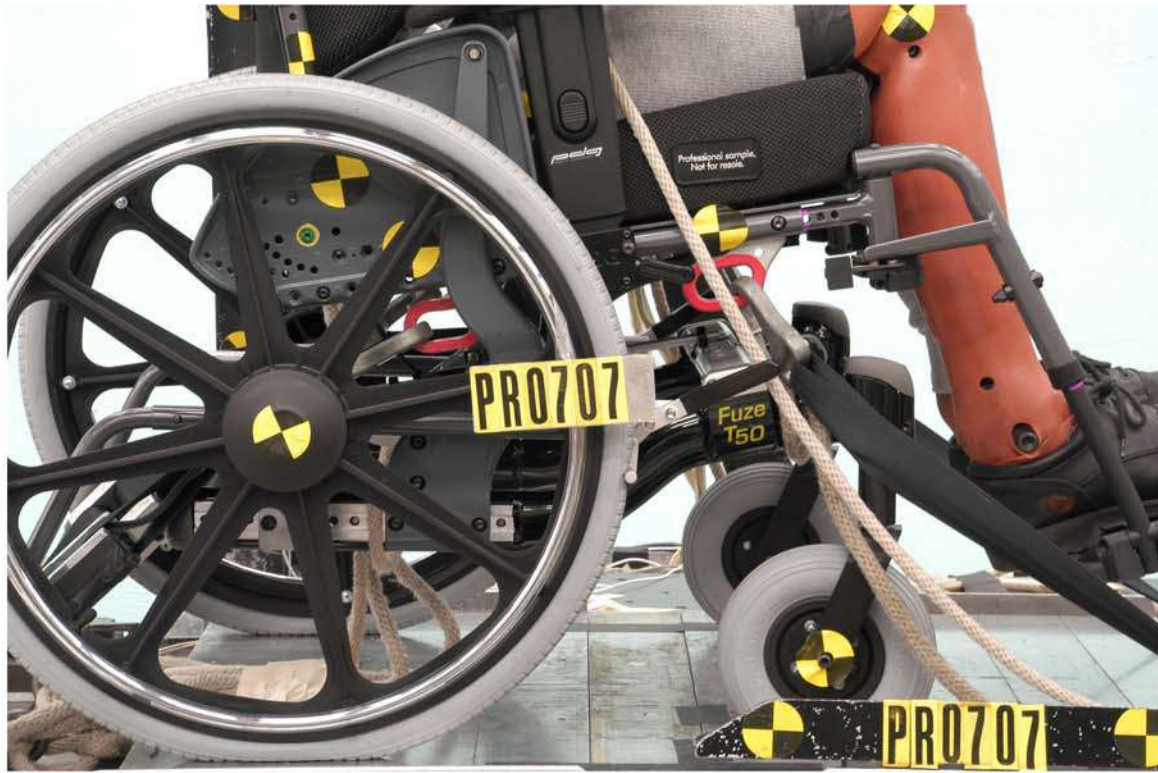
Note: WC = wheelchair, N/A –Not applicable

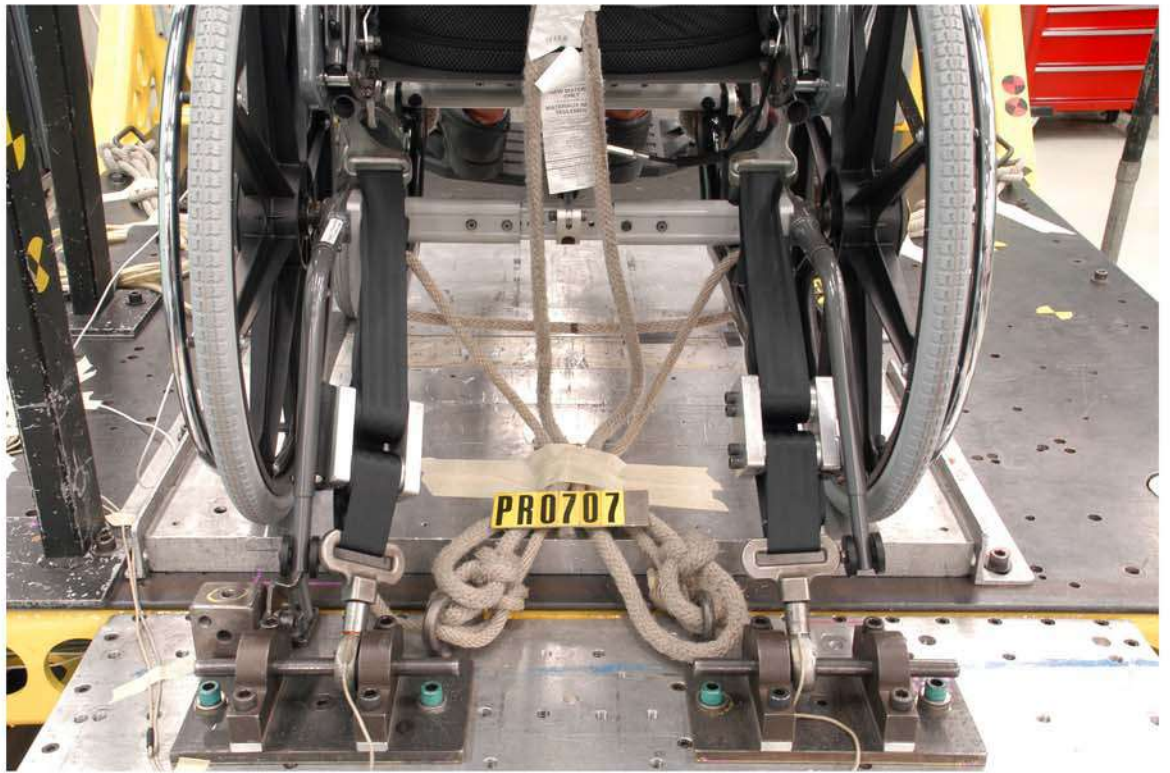
PRE-TEST PHOTOS

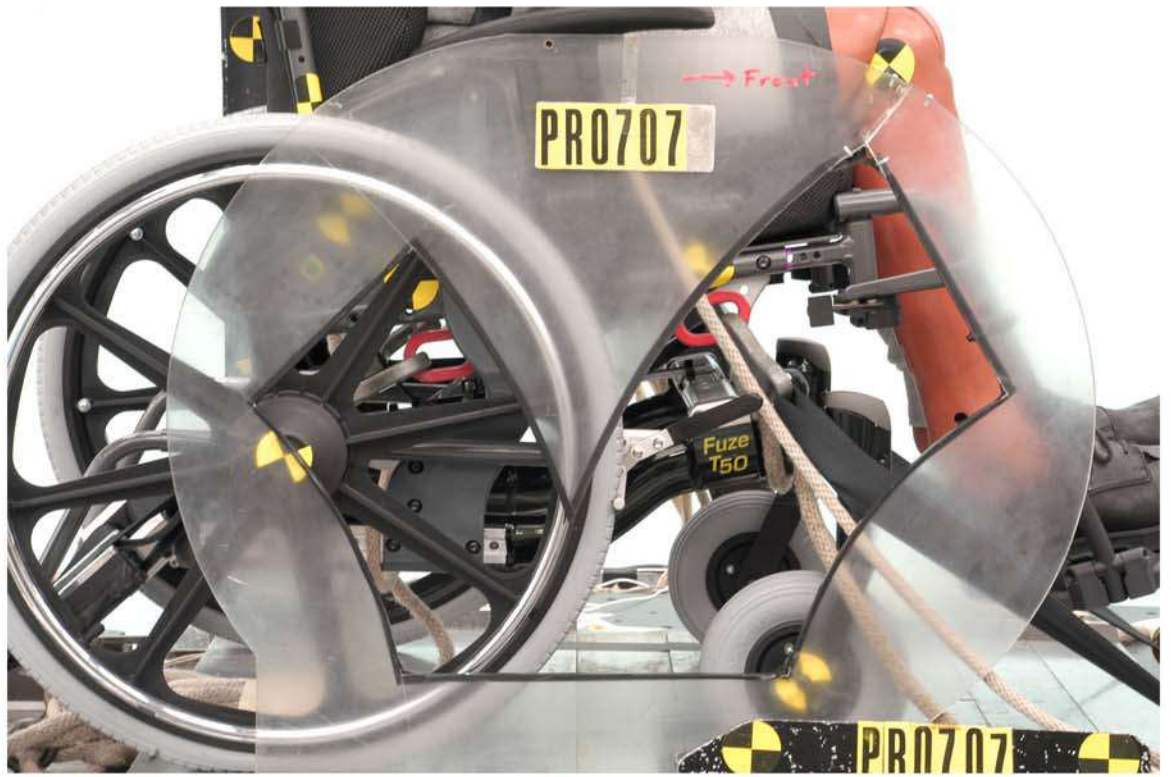












TEST AND POST-TEST PHOTOS

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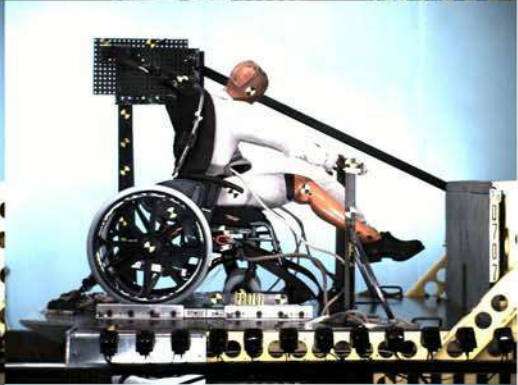
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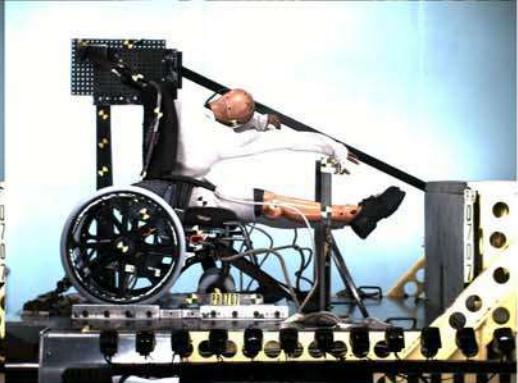
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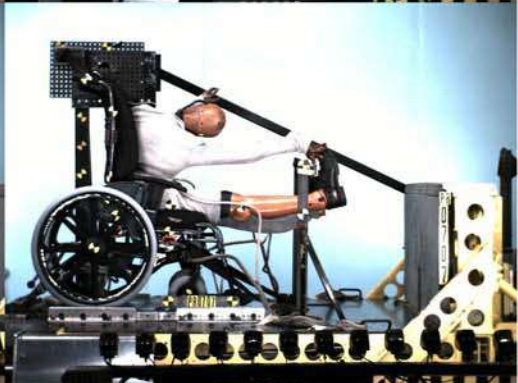
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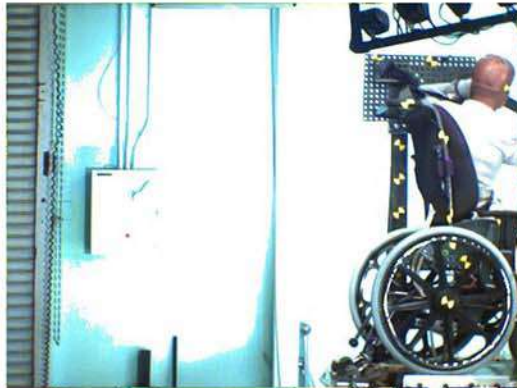


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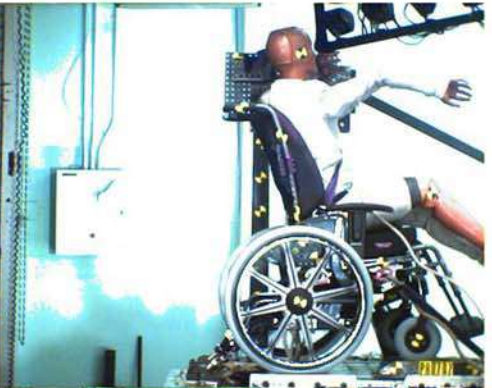


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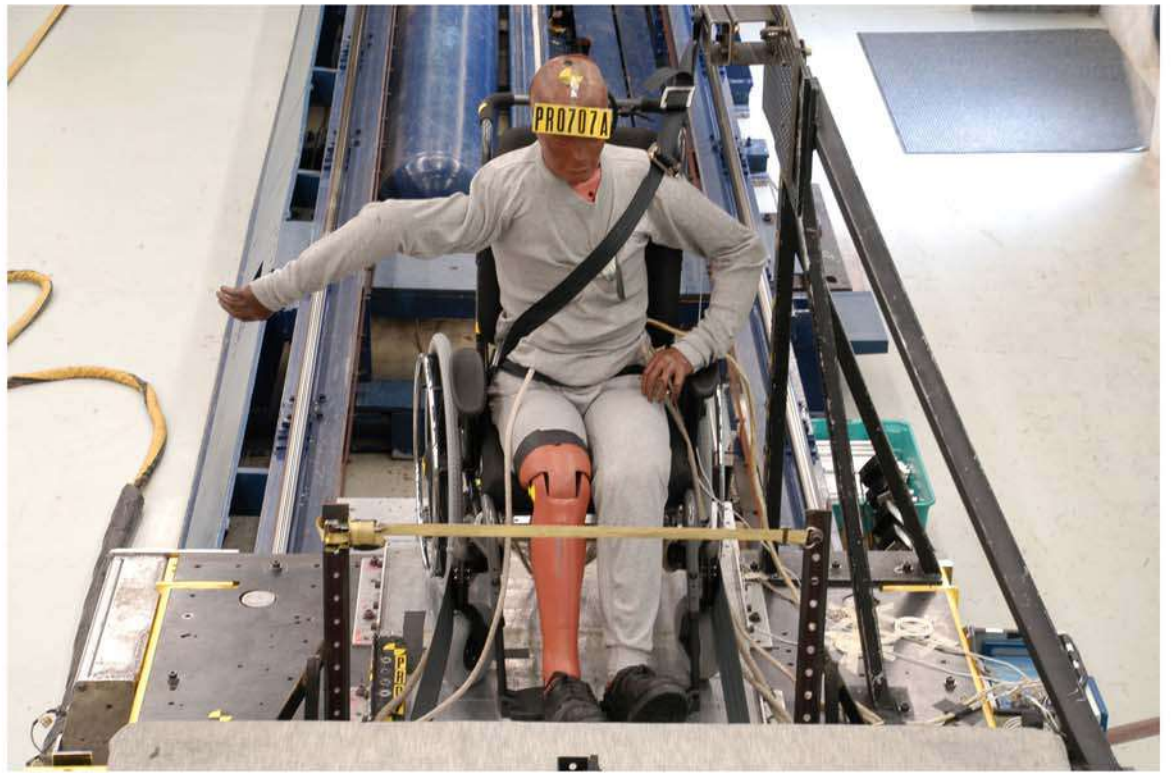


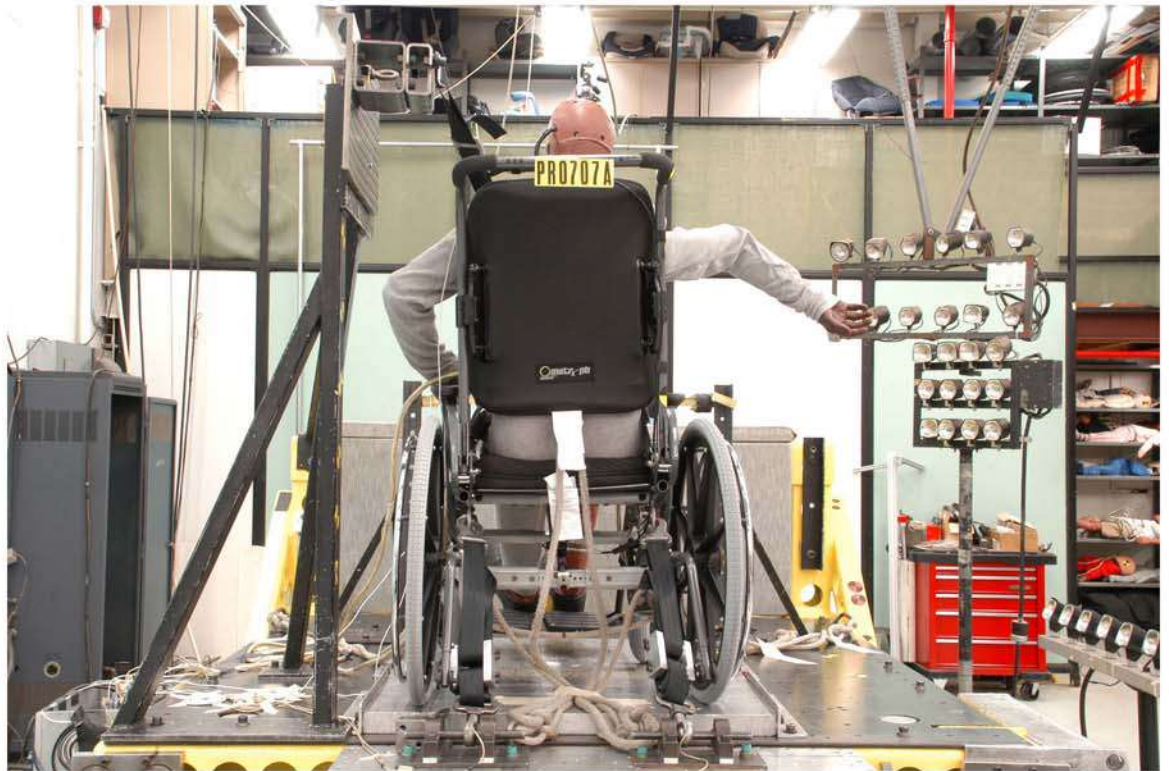
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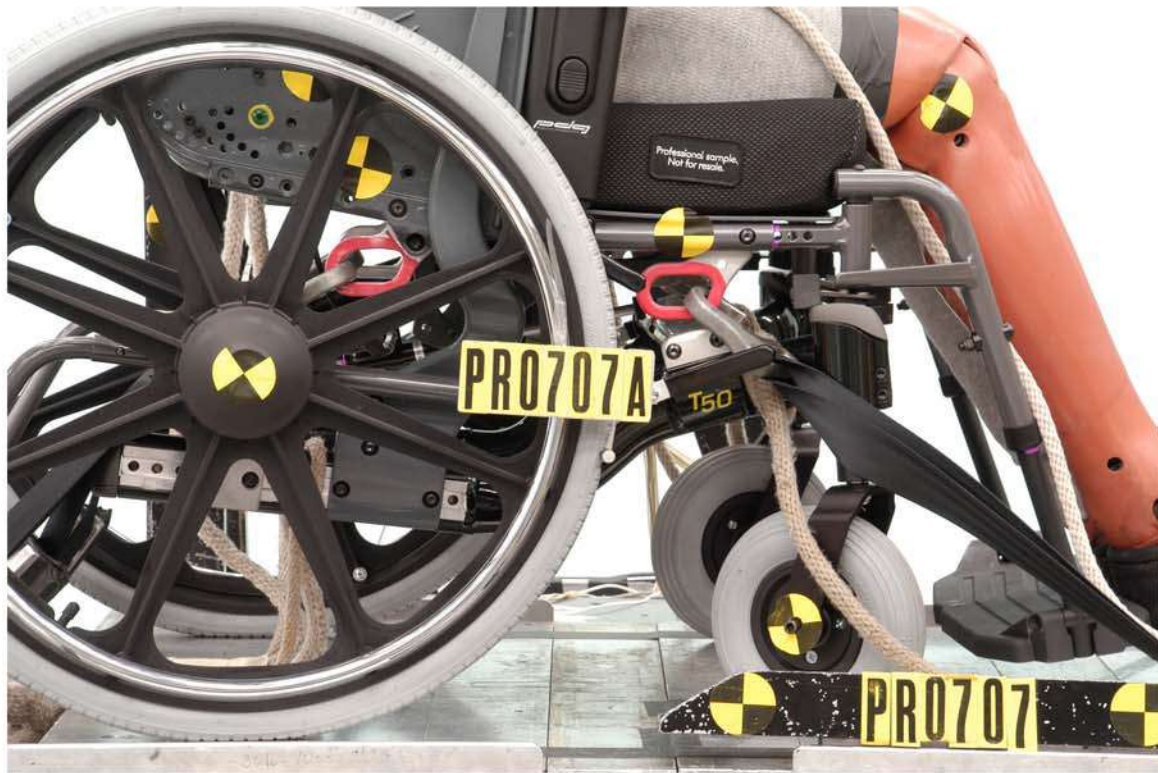
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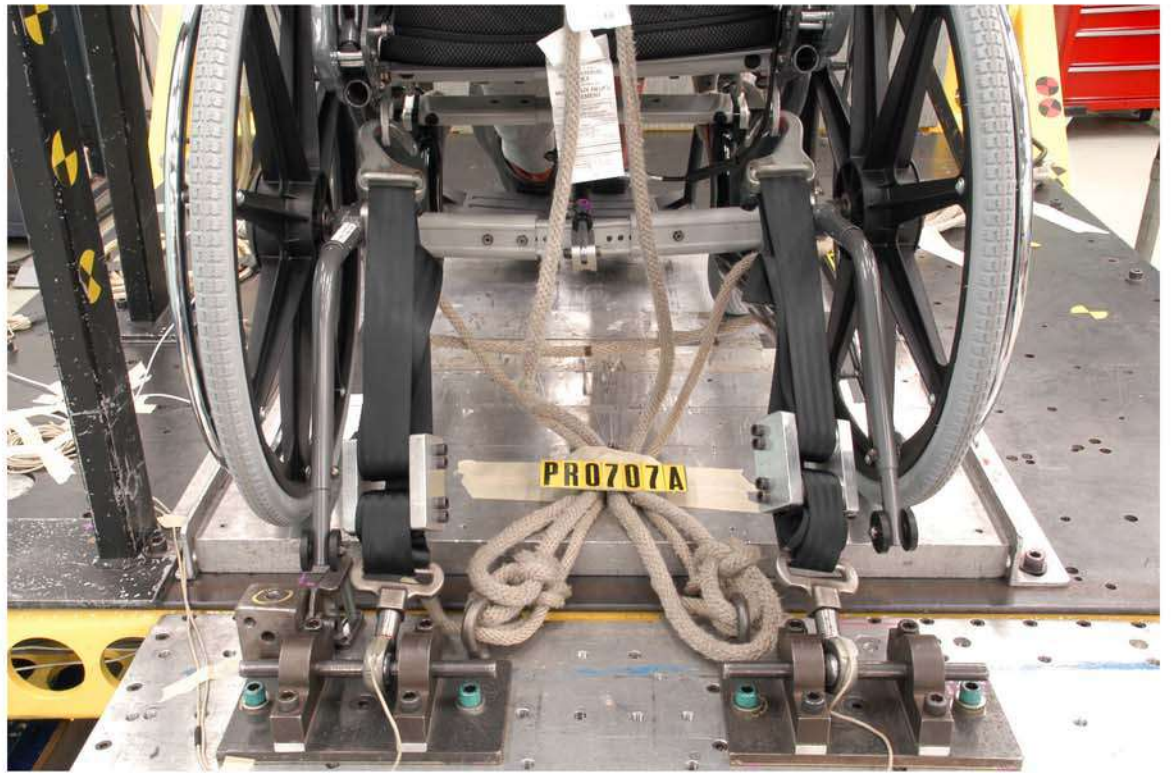






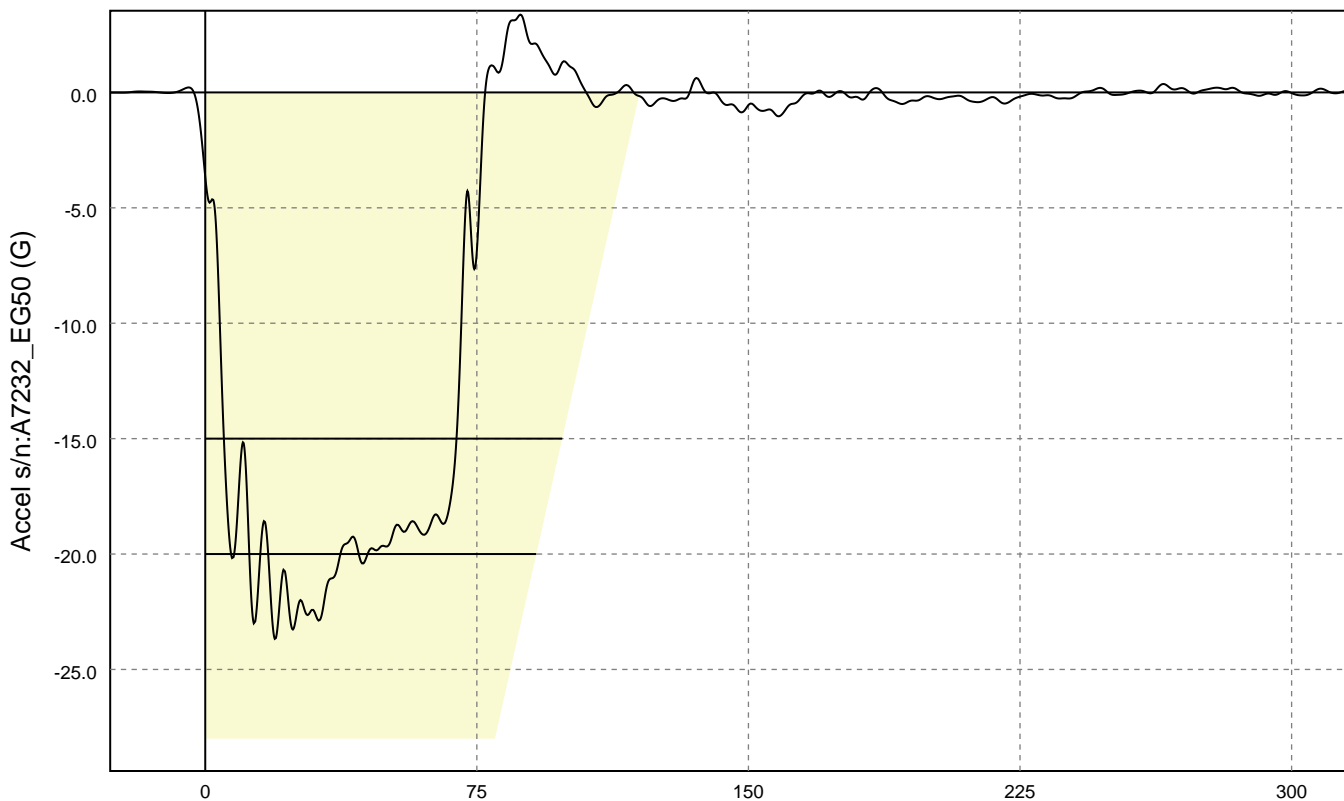
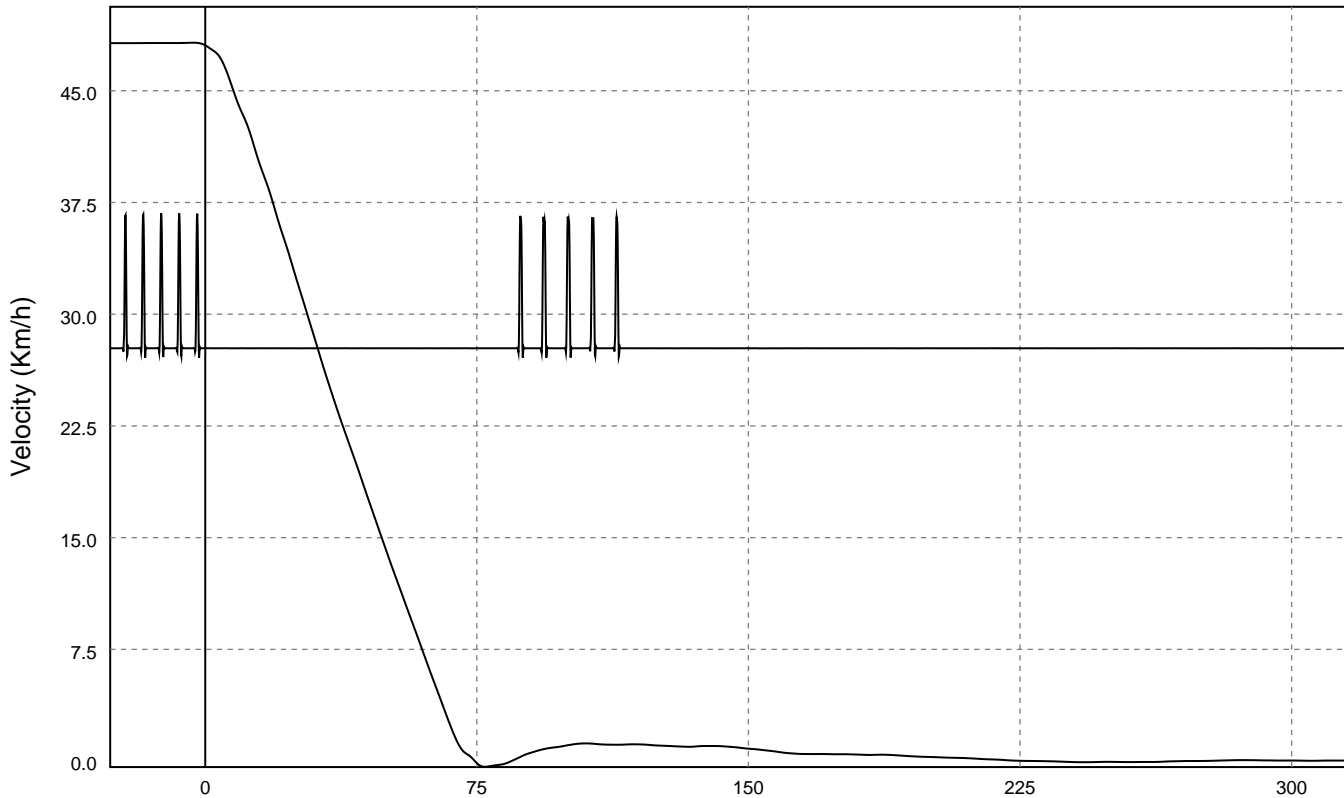






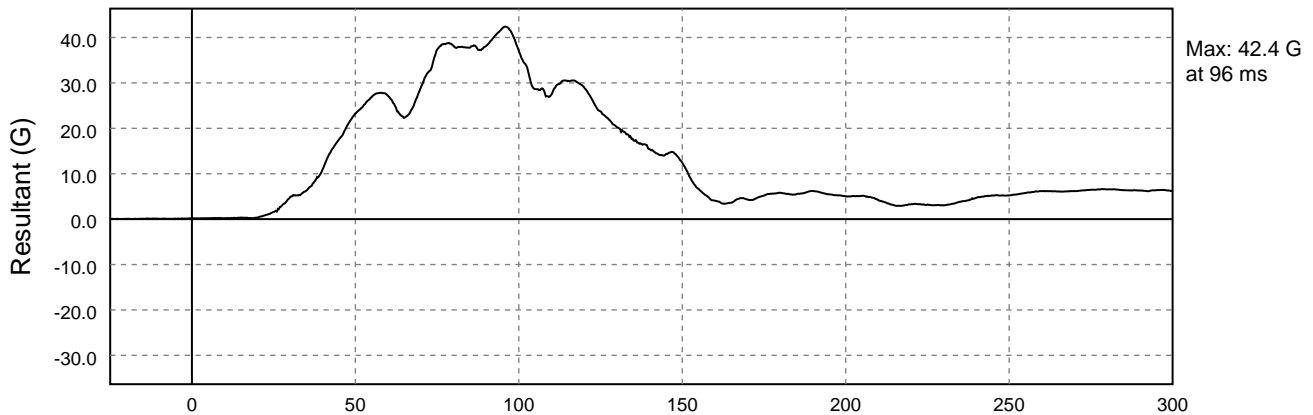
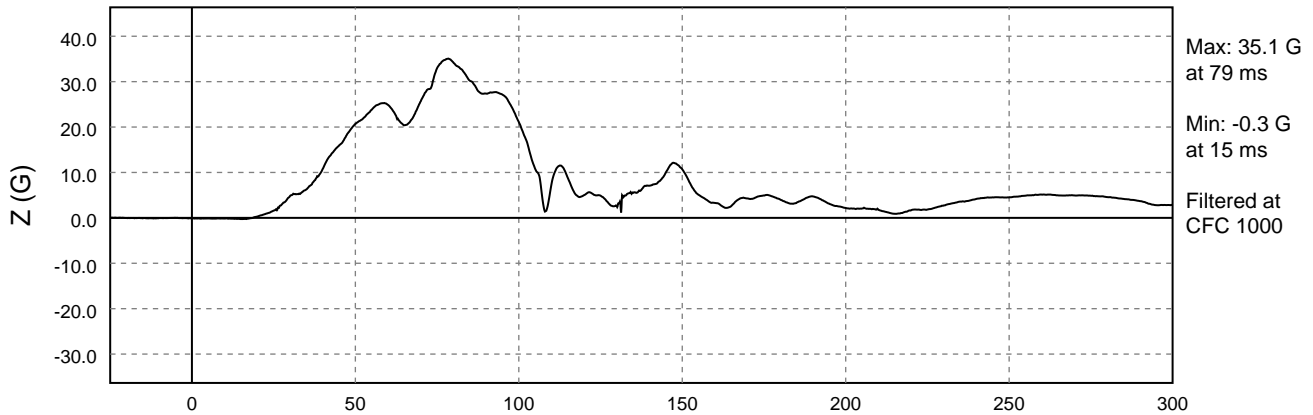
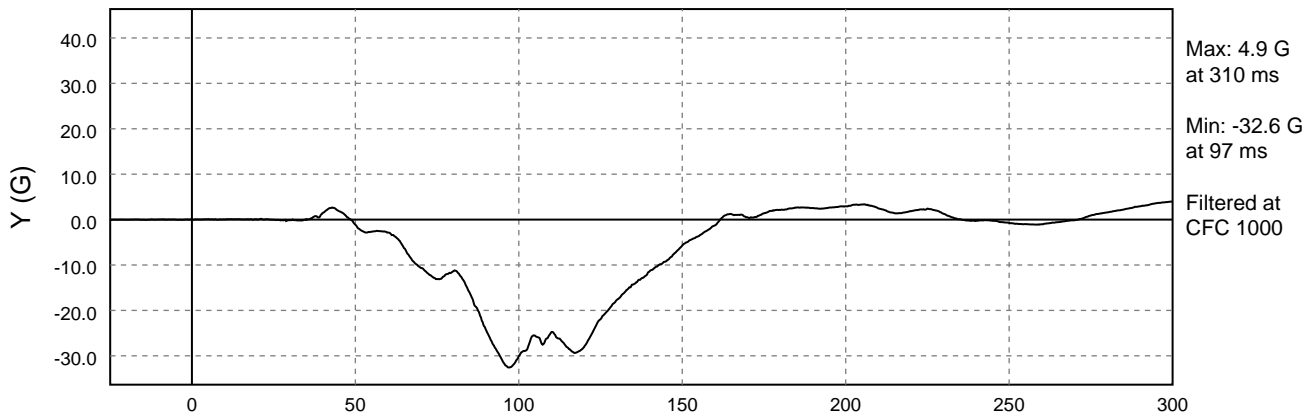
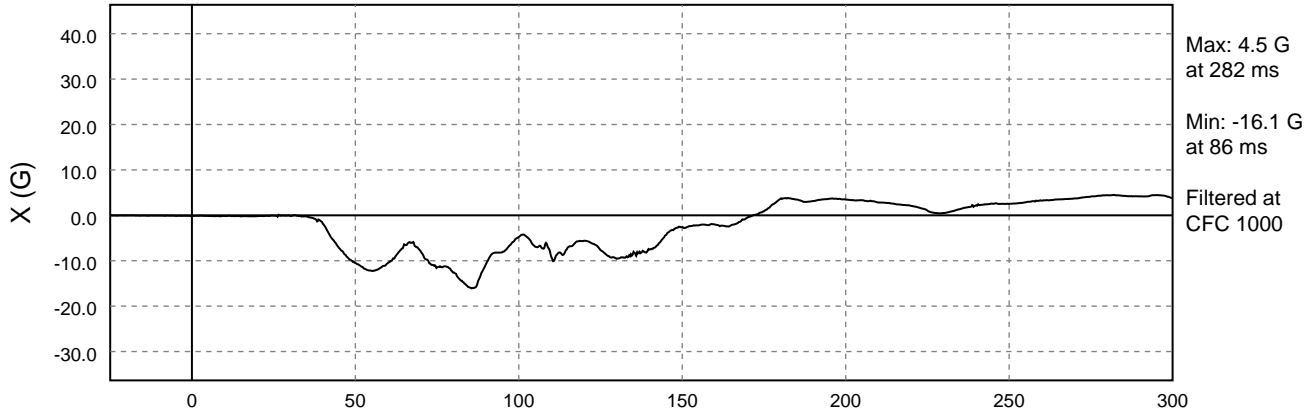


TEST SIGNALS



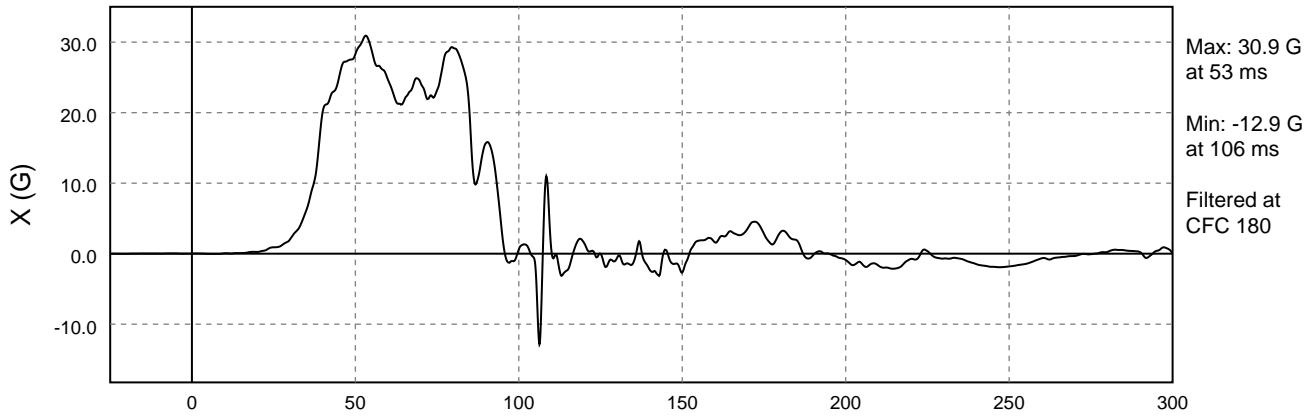
Continuous time under -15.0 G was 64.2 ms
Total time under -20.0 G was 26.4 ms
Sled Decel Peak = -23.7 G
Sled Plateau Average Level = -20.2 G
Sled Pulse Duration = 80.4 ms

Stopping Dist. (est) = 0.545 m
Sled Delta V = 48.3 kph (30.0 mph)
Efficiency = $V_{out} / V_{in} = 20.64 / 27.71 = 74.5\%$



H.I.C. (15) = 147.7
H.I.C. (UN) = 439.2

From: 84.7 to 99.7 ms
From: 45.5 to 134.3 ms



Total time over 60.0 G was 0.0 ms
3.0 ms Clipped Peak = 31.1G

From: 51.6 to 54.6 ms

