Sled Impact Test

PR 0402
Product Design Group, Inc.

Frontal Impact of PDG Stellar Tilt Wheelchair Secured by a Surrogate Four-Point, Strap-Type Tiedown Loaded with a Midsize Male ATD Restrained by a Three-Point Belt With Wheelchair-Anchored Lap Belt

Tested in accordance with Annex A of ANSI/RESNA WC/19
Wheelchairs Used as Seats in Motor Vehicles

Test Date: October 12, 2004

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 WC/19 or WC/19. 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 WC/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 WC/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 workstation and simultaneously multiplexed and recorded on the direct record channels of a Honeywell Model 9600 magnetic tape recorder. All signals were filtered to the requirements of SAE J-211.

The photo-instrumentation consisted of high-speed (1000-frames/sec) digital video cameras for views of the impact event. A Polaroid® graph-check camera was also used to provide a quick-look sequenced photograph of the impact event. A strobe flash and simultaneous voltage pulse record and synchronize the onset of impact deceleration on film, video, and transducer data.

TEST SETUP

The PDG Stellar Tilt wheelchair was placed on the sled platform facing forward and secured using the surrogate four-point, strap-type tiedown specified in Annex D of WC/19. 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 midsize male anthropomorphic test device (ATD) that was restrained by a three-point belt with wheelchair-anchored Q'Straint lap belt and surrogate shoulder belt. The ends of the lap belt were bolted to the wheelchair seat frame below and behind the seatpan-seatback junction on both sides of the wheelchair. The shoulder-belt lower anchorage was attached to the pin-bushing connector on the tongue of the lap-belt buckle assembly. The upper anchorage of the shoulder belt 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 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

GENERAL TEST INFORMATION	
Test number	PR 0402
Test date	October 12, 2004
Wheelchair type	PDG Stellar Tilt wheelchair
Wheelchair tiedown	Surrogate four-point, strap-type tiedown
Occupant restraint	Three-point belt with WC-anchored Q'Straint lap belt and surrogate shoulder belt
Anthropomorphic Test Dummy (ATD)	Midsize-male ATD @ 76.4 kg (168 lb)
Wheelchair orientation	Forward facing
Sled platform	Rigid steel plate
Desired impact velocity (ΔV)	48 kph (30 mph)
Desired average sled deceleration	20 *g*
WHEELCHAIR TIEDOWN	
Front-to-rear anchor-point distance	1295 mm (51.0 in)
Rear tiedowns	
Lateral distance between anchor points	483 mm (19.0 in)
Angle wrt horizontal	18 degrees
Angle wrt to wheelchair center plane	0 degrees
Anchor point to rear-wheel hub	635 mm (25.0 in)
Length (anchor point to securement point)	495 mm (19.5 in)
Front tiedowns	
Lateral distance between anchor points	711 mm (28.0 in)
Angle wrt horizontal	46 degrees
Angle wrt to wheelchair center plane	13 degrees
Length (anchor point to securement point)	546 mm (21.5 in)
OCCUPANT RESTRAINT	
Shoulder belt upper anchor point location	
Behind ATD shoulder	305 mm (12.0 in)
Above ATD shoulder	178 mm (7.0 in)
Above sled platform	1080 mm (42.5 in)
Left of wheelchair centerline	292 mm (11.5 in)
Angle of pelvic belt wrt to horizontal	57 degrees
Angle of shoulder-belt	
Projected frontal view wrt horizontal	48 degrees, measured on ATD torso
Projected lateral view wrt horizontal	30 degrees, measured above ATD shoulder
ATD POSITIONING	
Shoulder height above sled platform	927 mm (36.5 in)
H-point height above sled platform	432 mm (17.0 in)
WHEELCHAIR	
Weight	28.6 kg (63 lb)
Wheelbase	381 mm (15.0 in)
Seatback angle wrt vertical	20 degrees
Seatback height (with headrest)	572 mm (22.5 in)
Seatpan angle wrt horizontal	14 degrees
Seat surface height from floor @ SB junction	305 mm (12.0 in)
Seatpan length	457 mm (18.0 in)

TEST RESULTS

The PDG Stellar Tilt wheelchair was effectively secured during frontal impact loading with minimal frame deformation. There were no signs of failure to any primary load-carrying structural components, but the shaft of the left-front caster was bent rearward. The maximum forward excursion of point P on the wheelchair seating system was 36 mm, which is below the WC/19 excursion limit of 200 mm. The wheelchair was in an upright position at the completion of the test and the ATD was in the seat with the torso upright.

The front and rear securement-point brackets were deformed but there were no signs of failure or detachment from the wheelchair. All tiedown hooks could be removed from the wheelchair securement points and the ATD could be removed from the occupant restraint system without the use of tools.

The ATD was effectively restrained from forward excursion by the surrogate shoulder belt and Q'Straint wheelchair-anchored lap belt. Peak forward head excursion was limited to approximately 480 mm, and peak forward knee excursion was limited to about 314 mm, which are both below the WC/19 limits of 650 mm and 375 mm, respectively. The ratio of the ATD's knee excursion to the wheelchair point-P excursion is 8.7, which is above the minimum required ratio of 1.1. The ATD's head traveled approximately 254 mm rearward from its initial position during the test, which meets the 450 mm rearward excursion limit initial position. The ATD H-point height decreased 6%, which complies with the maximum allowed decrease of 20%.

The results of this test show that the PDG Stellar Tilt wheelchair with wheelchair-anchore Q'Straint 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	PR 0402
Actual impact velocity (ΔV)	48 kph (29.8 mph)
Actual average sled deceleration level	20.0 g
Actual peak sled deceleration level	21.8 g
Total time of deceleration over 20 *g*	26.8 ms
Total time of deceleration over 15 *g*	66.3 ms
Deceleration pulse duration	83.6 ms
ATD MEASUREMENTS	
Peak resultant head acceleration	54 g
Peak resultant chest acceleration	41 g
HIC (15)	264
Maximum forward head excursion†	480 mm (18.9 in)
Maximum forward knee excursion††	314 mm (12.4 in)
Maximum rearward head excursion††	254 mm (10.0 in)
Average post-test H-pt ht above sled platform	406 mm (16.0 in) 6% change
TIEDOWN LOADS	
Peak left-rear tiedown strap force	15791 N (3550 lb)
Peak right-rear tiedown strap force	17993 N (4045 lb)
BELT LOADS AND PELVIC BELT ANGLE	
Peak left pelvic-belt load	9919 N (2230 lb)
Peak shoulder-belt load	10209 N (2295 lb)
Post-test pelvic restraint angle	60 degrees
WHEELCHAIR MEASUREMENTS††	
Maximum forward wheelchair excursion at Point P*	36 mm (1.4 in)
Maximum forward excursion of front-wheel hub	-29 mm (-1.1 in)**
Maximum forward excursion of rear-wheel hub	3 mm (0.1 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.

** Negative excursion indicates that the front wheel moved rearward during impact.

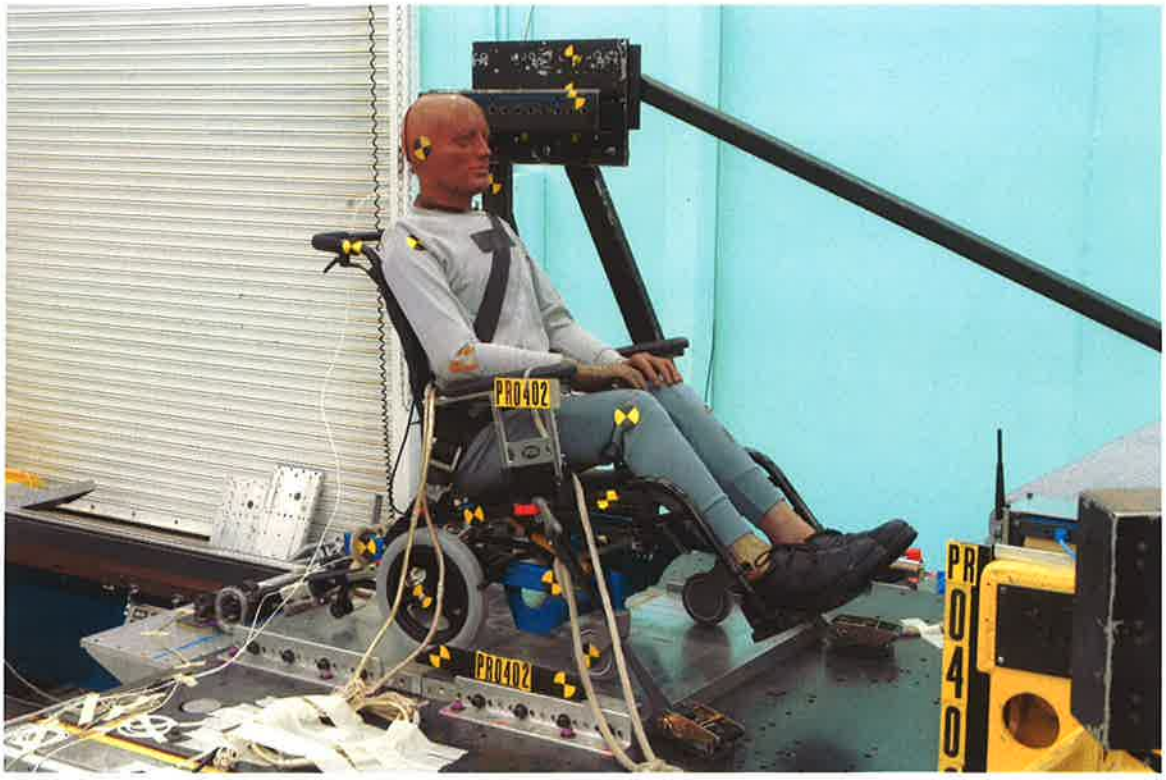
SUMMARY OF WHEELCHAIR PERFORMANCE TO WC/19
SLED TEST PR 0402

Requirement		Observed Performance	
WC/19 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	All four securement-point brackets deformed but all tiedown hooks could be disengaged	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 seated in the wheelchair the torso upright	Pass
5.3e	Detached hardware cannot exceed 100g	No hardware detached	Pass
5.3f	WC must not have sharp edges with potential for occupant contact	No sharp edges near occupant	Pass
5.3g	Primary WC components cannot show visible signs of structural failure that is not anticipated by WC design	No signs of failure in any primary load-carrying structural components	Pass
5.3h	Forward excursion of Point P<200 mm	36 mm	Pass
	Forward knee excursion <375 mm	314 mm	Pass
	Forward head excursion <650 mm	480 mm	Pass
	Rearward head excursion <450 mm	254 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 = 8.7	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 6%	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.liii	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 WTORS failure	Pass

Note: WC = wheelchair

PRE-TEST PHOTOS


PRO402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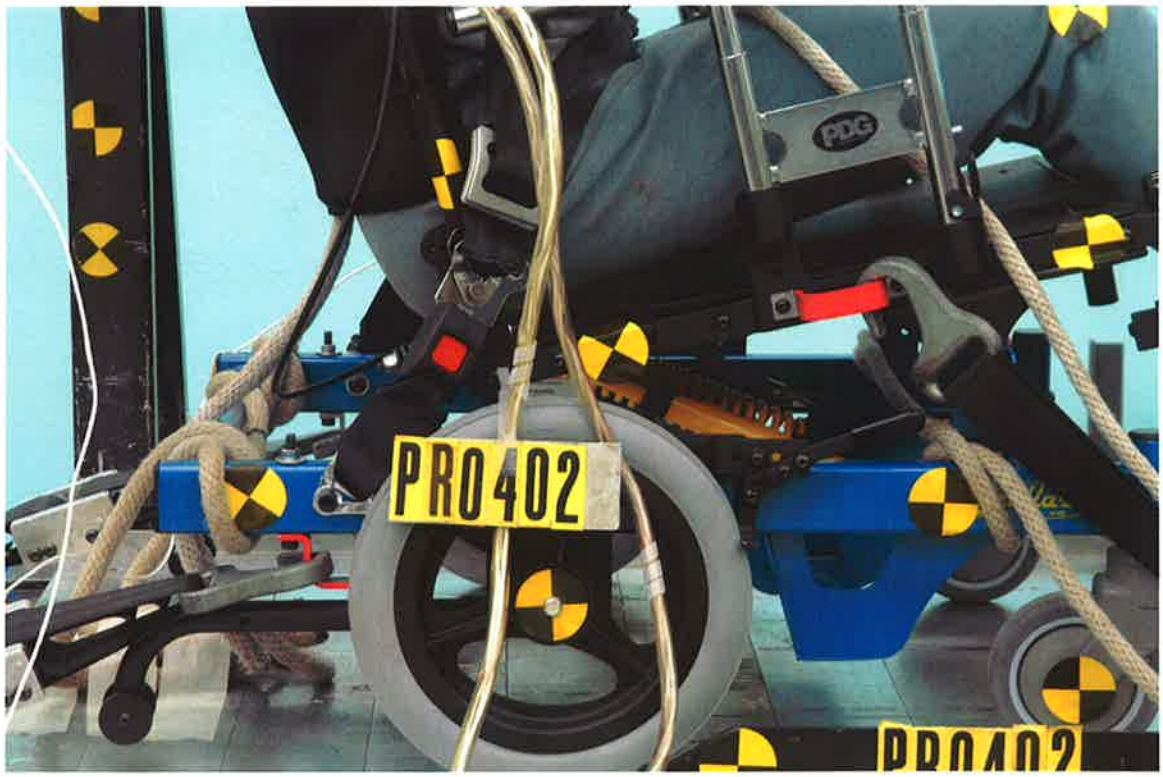
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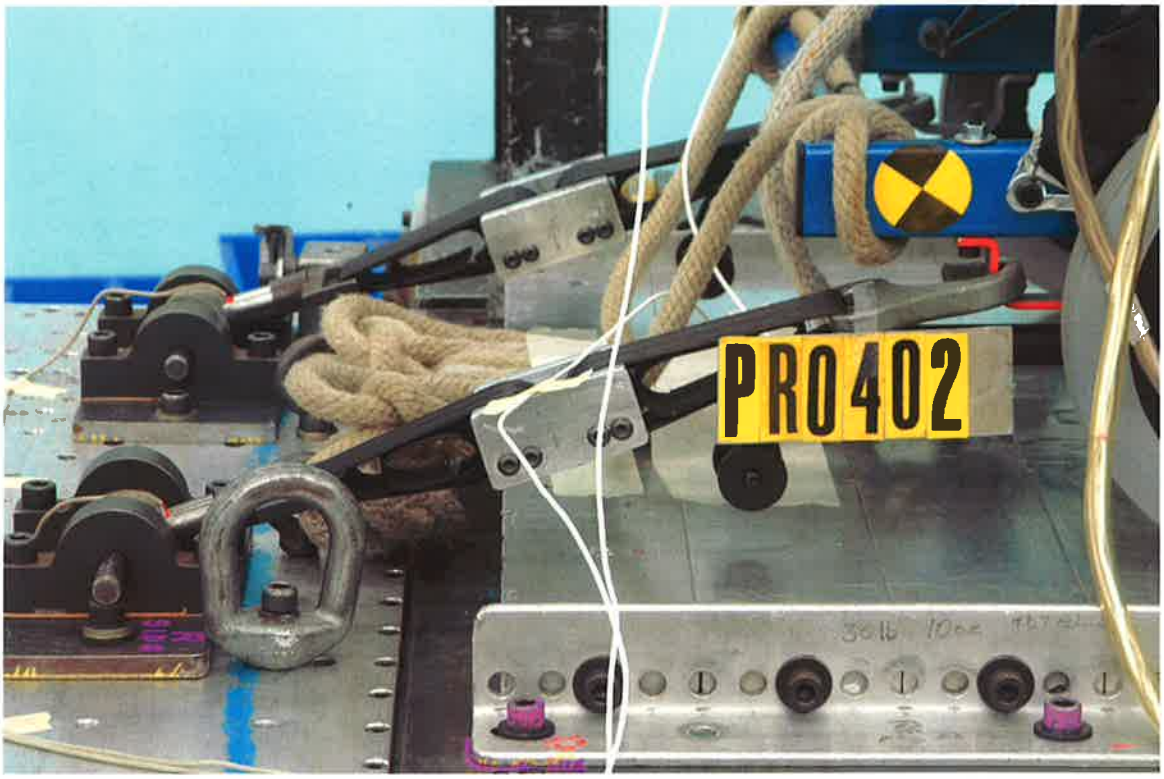
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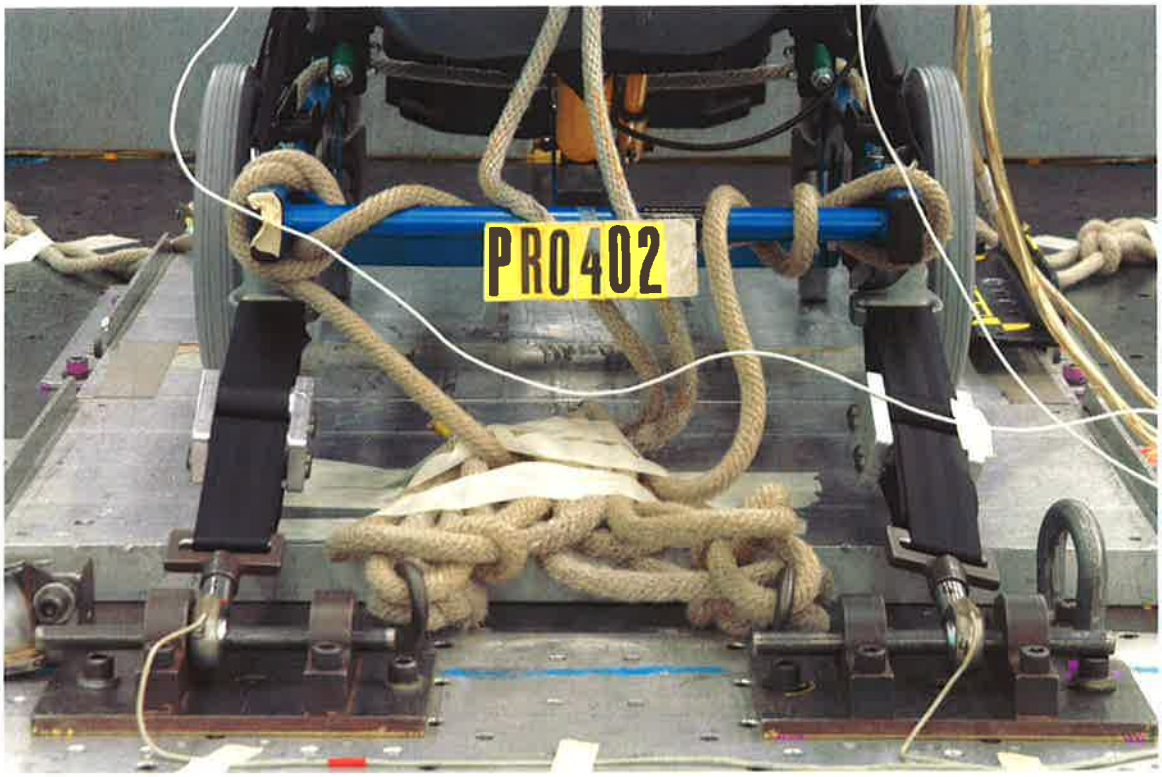
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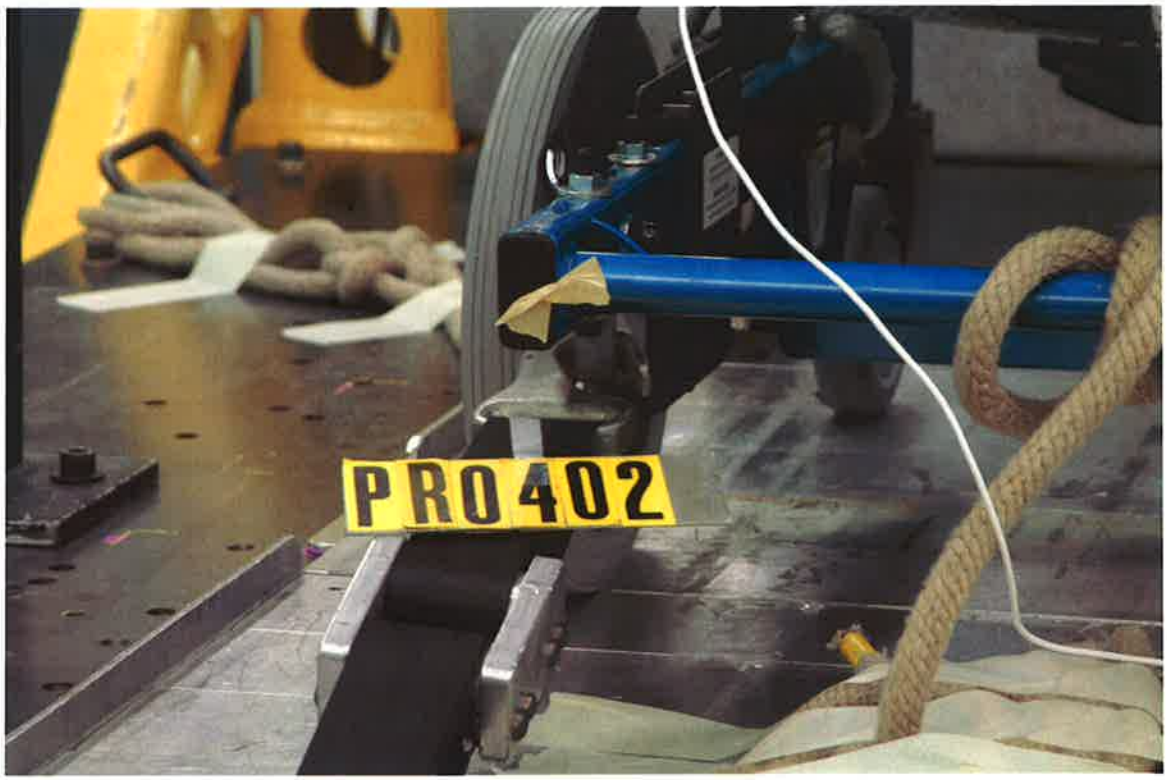
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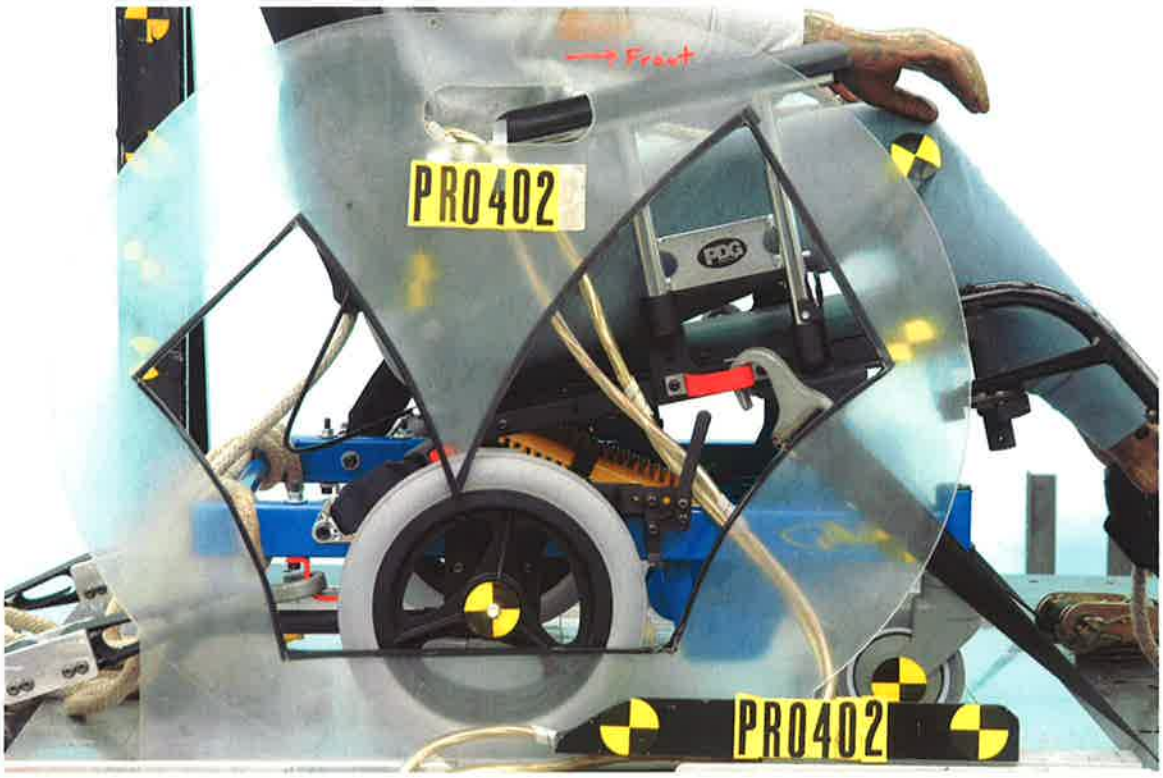
Front
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PDG
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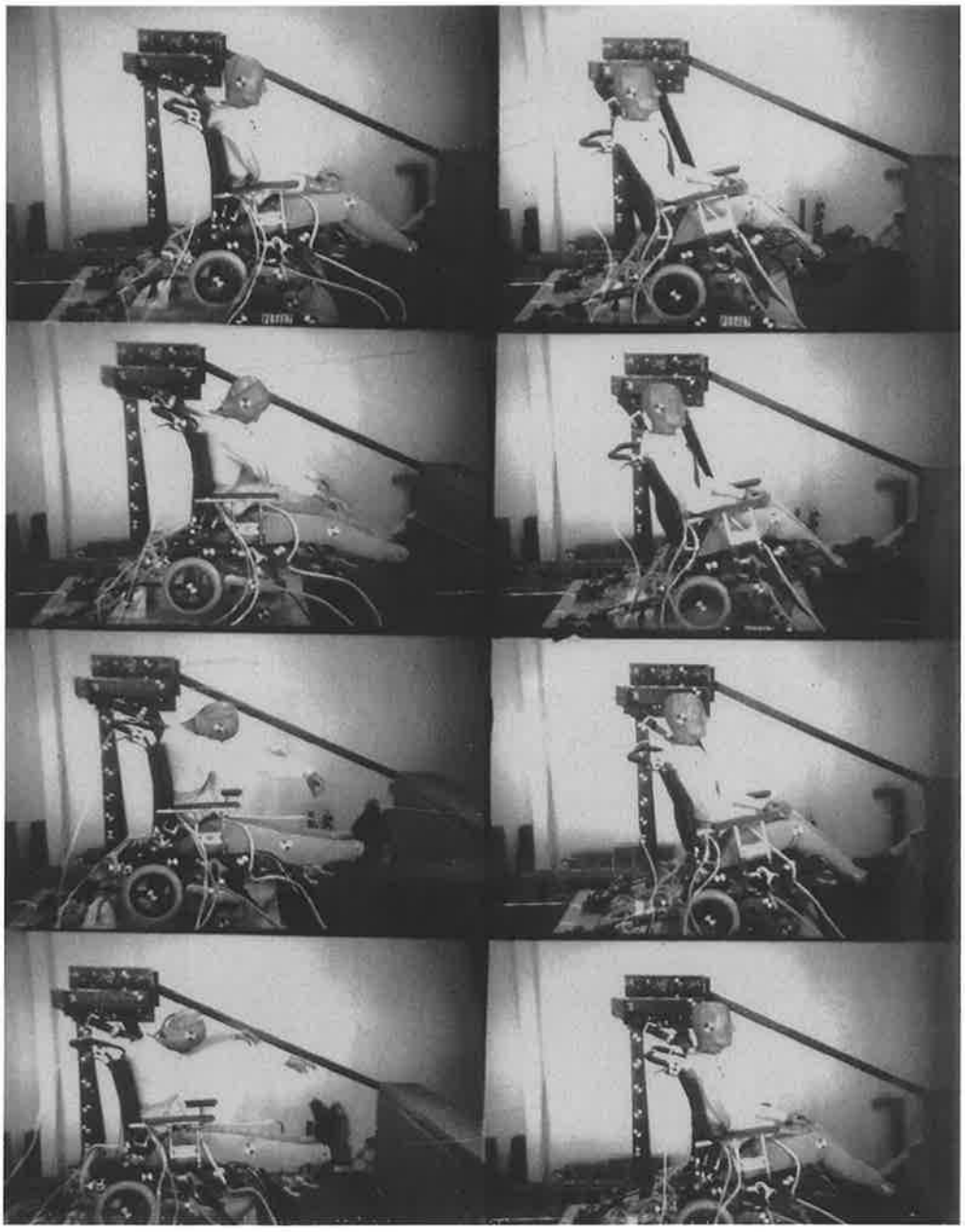
TEST AND POST-TEST PHOTOS

PR0402

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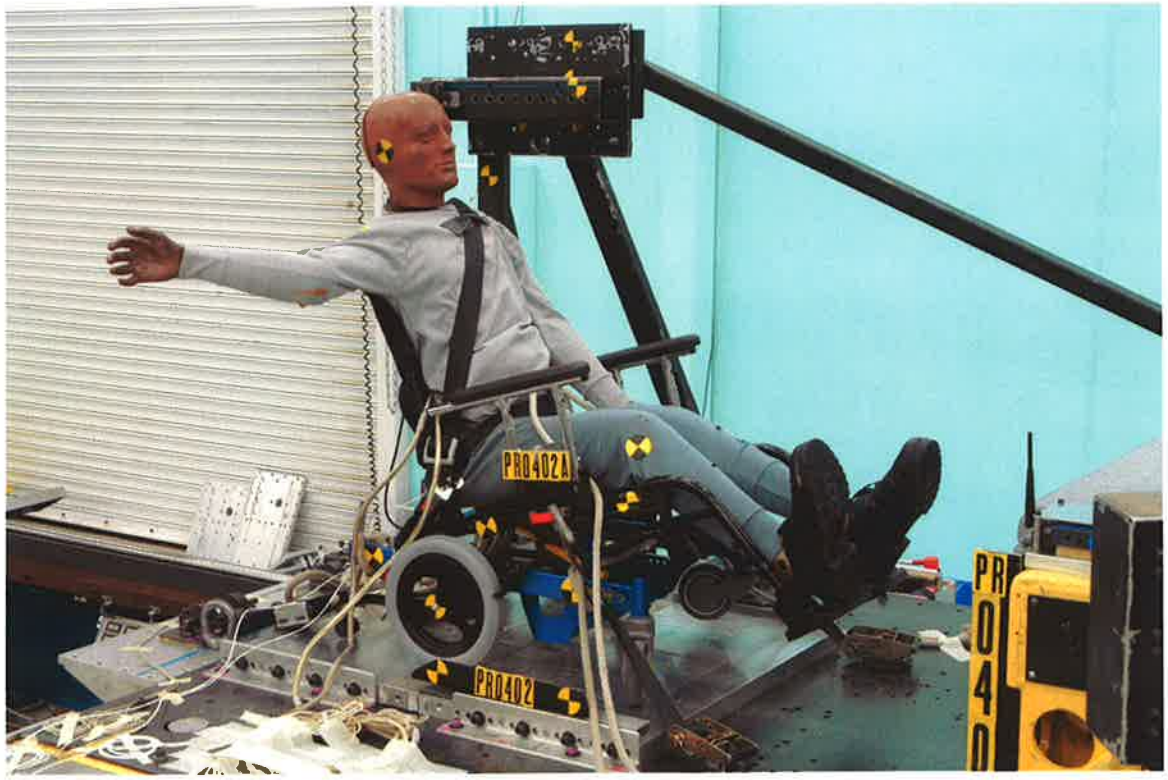
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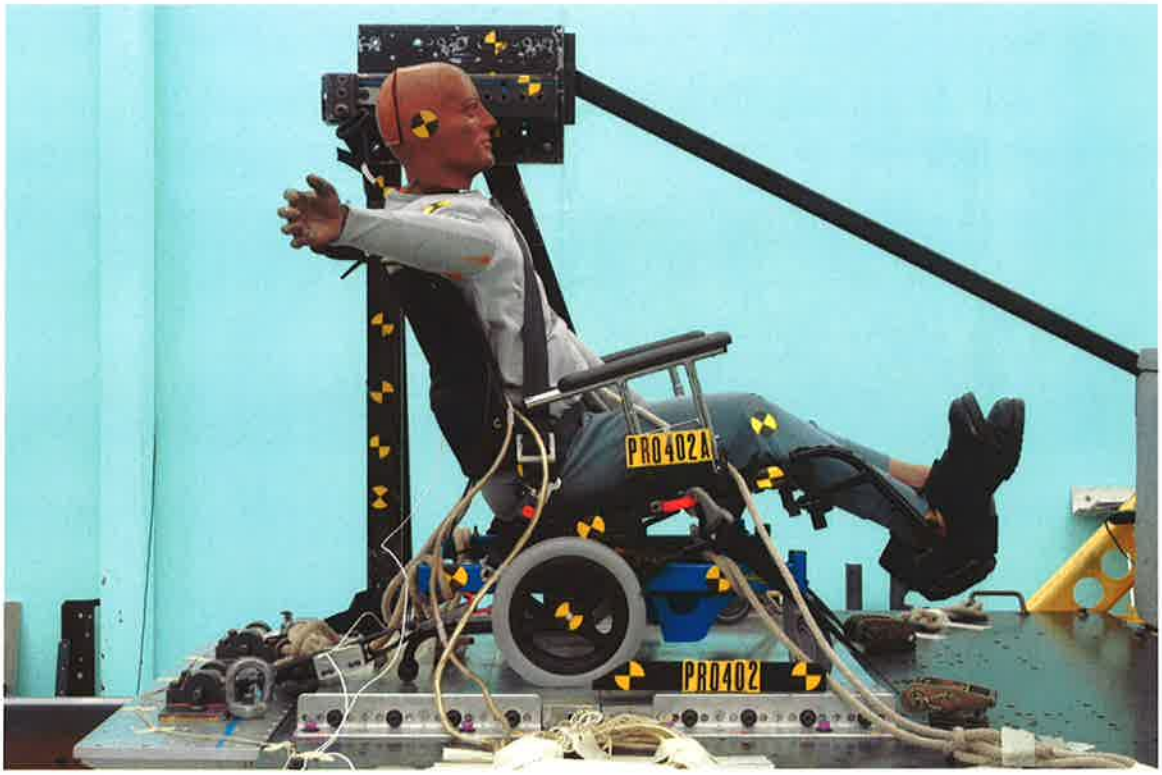
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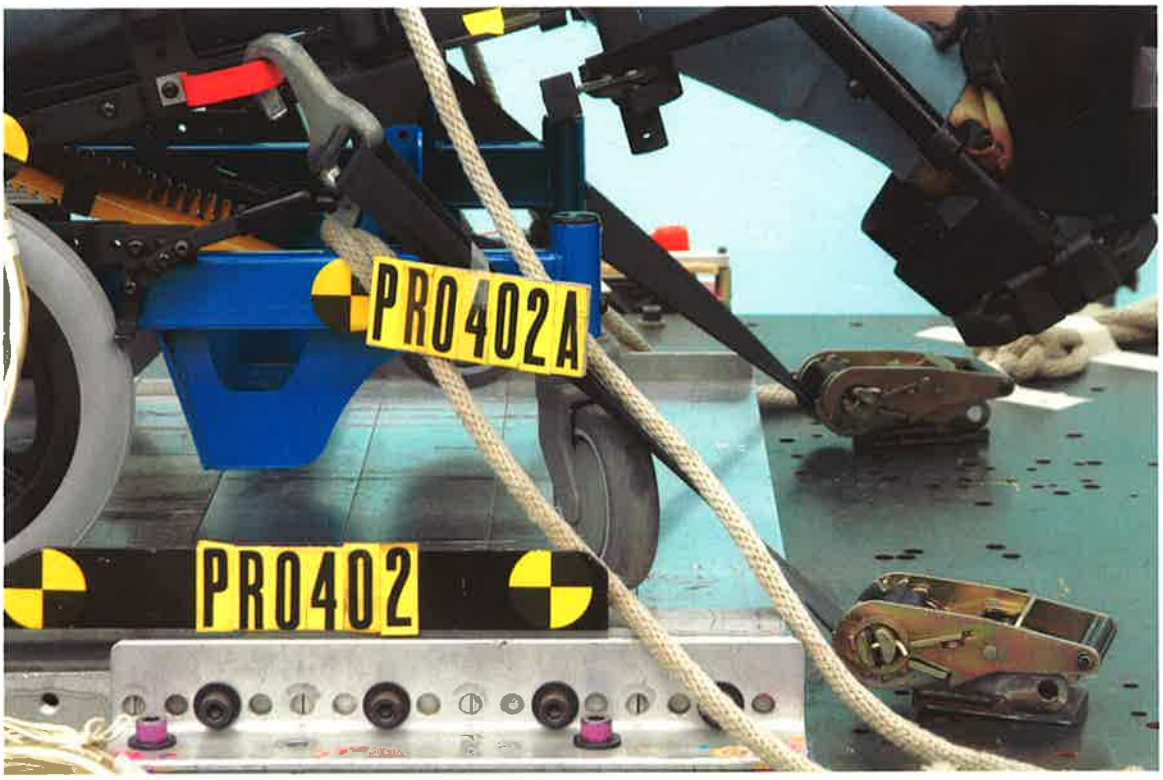
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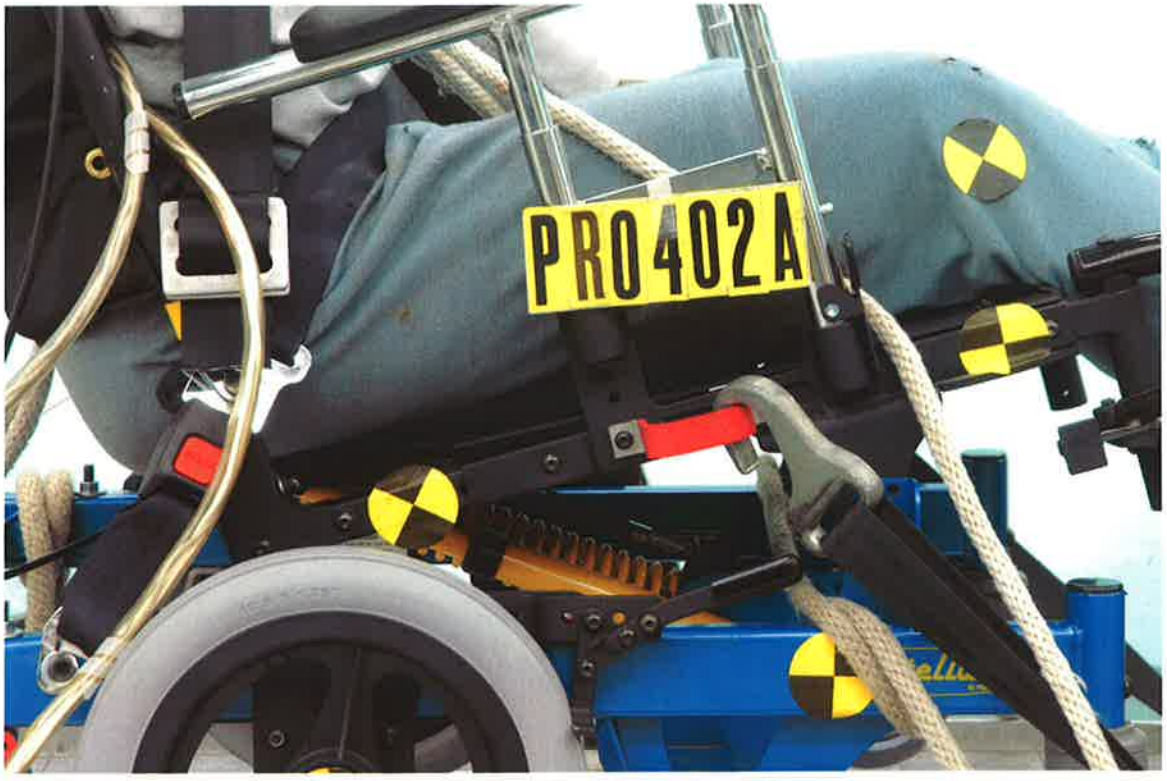
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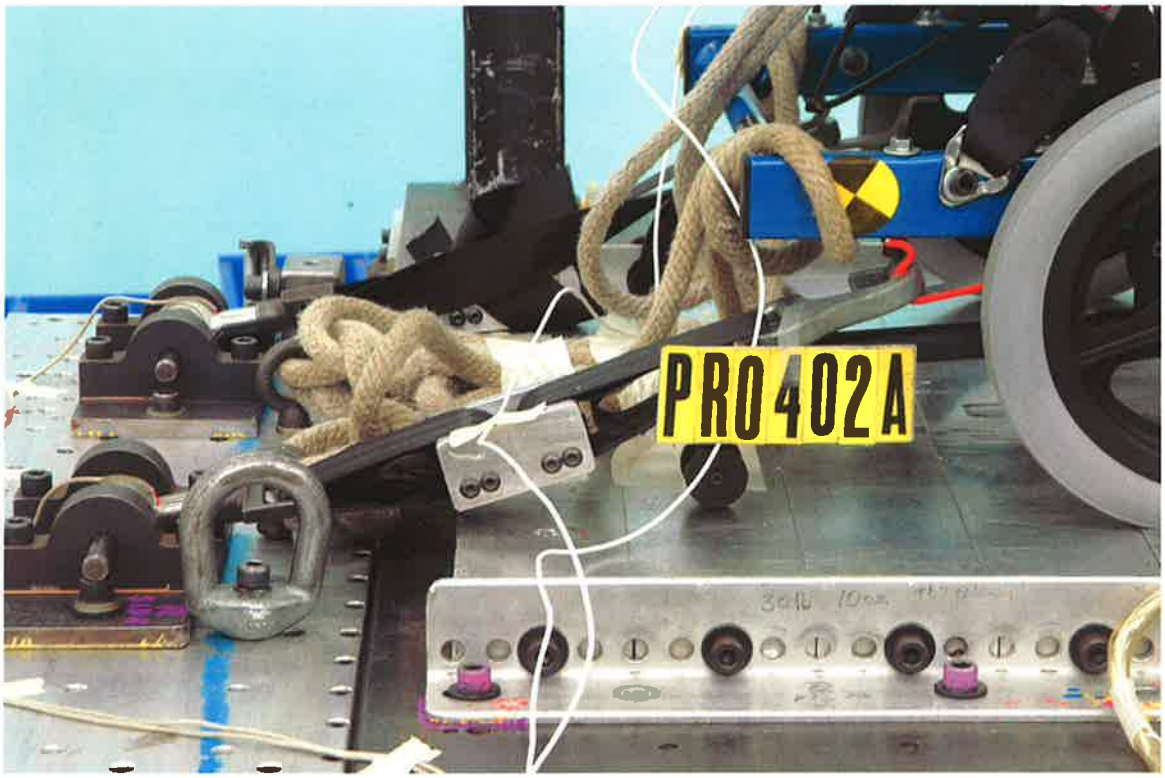
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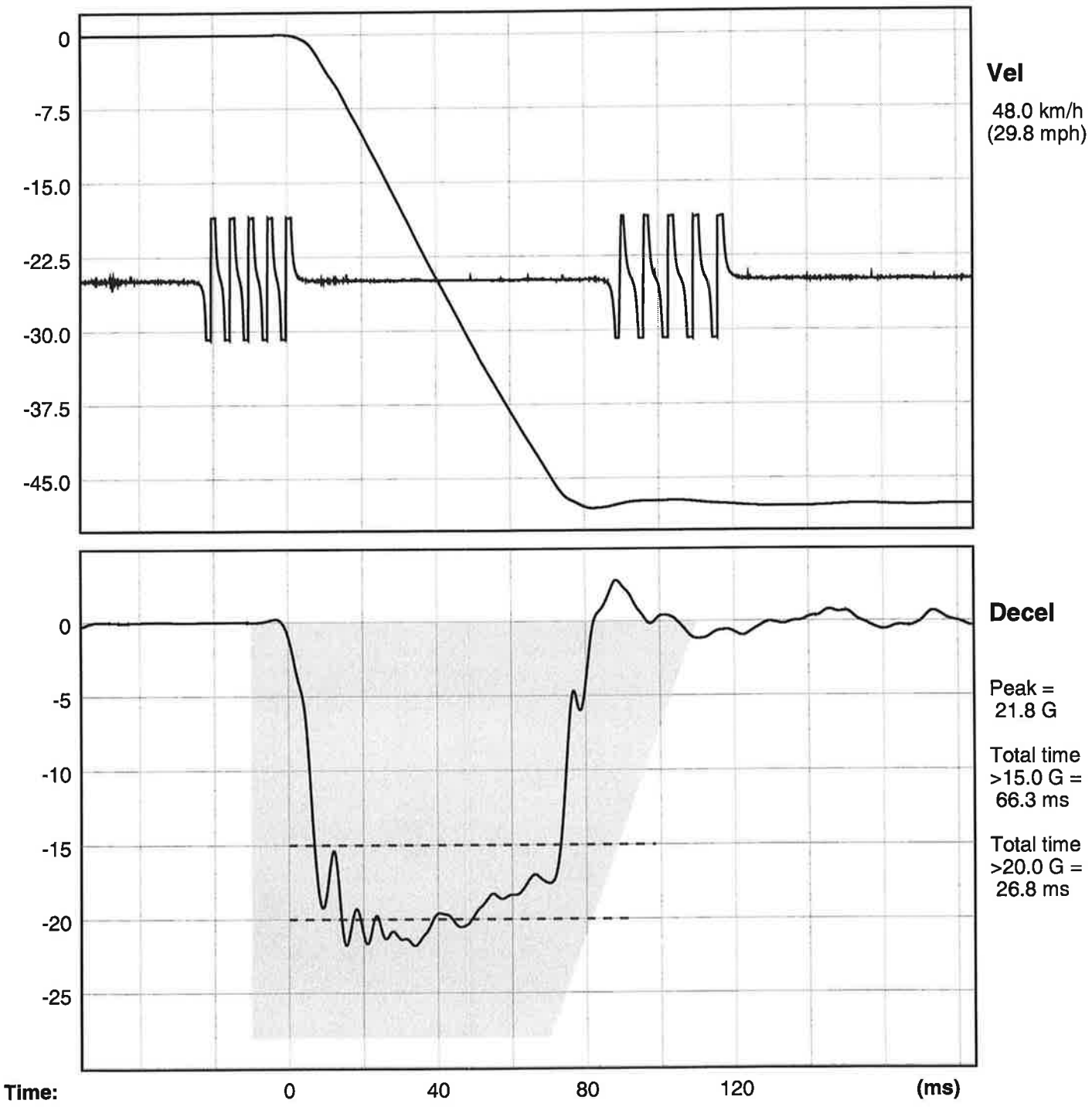
TEST SIGNALS

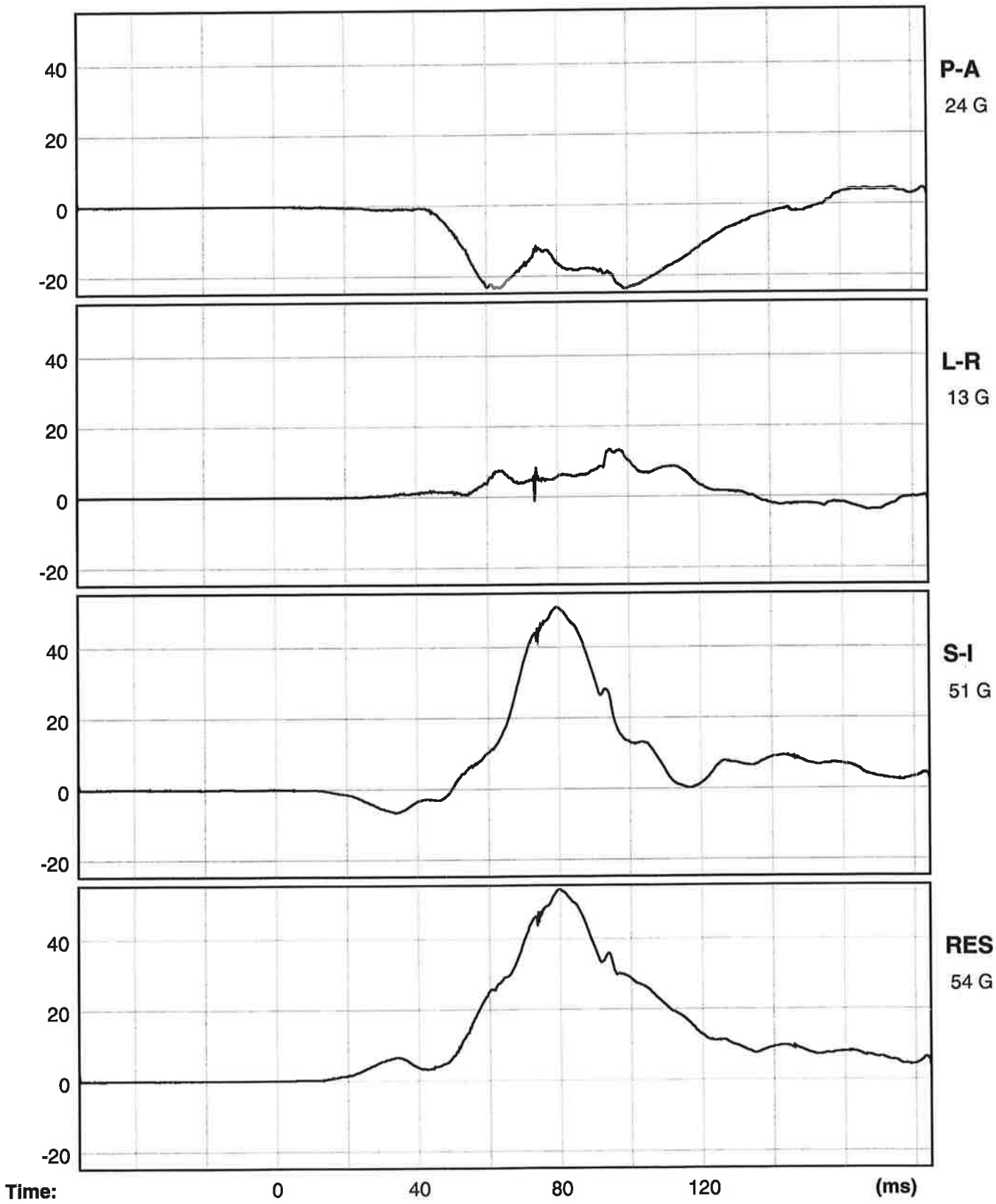
SLED Deceleration

PR 0402



HEAD Accelerations

PR 0402



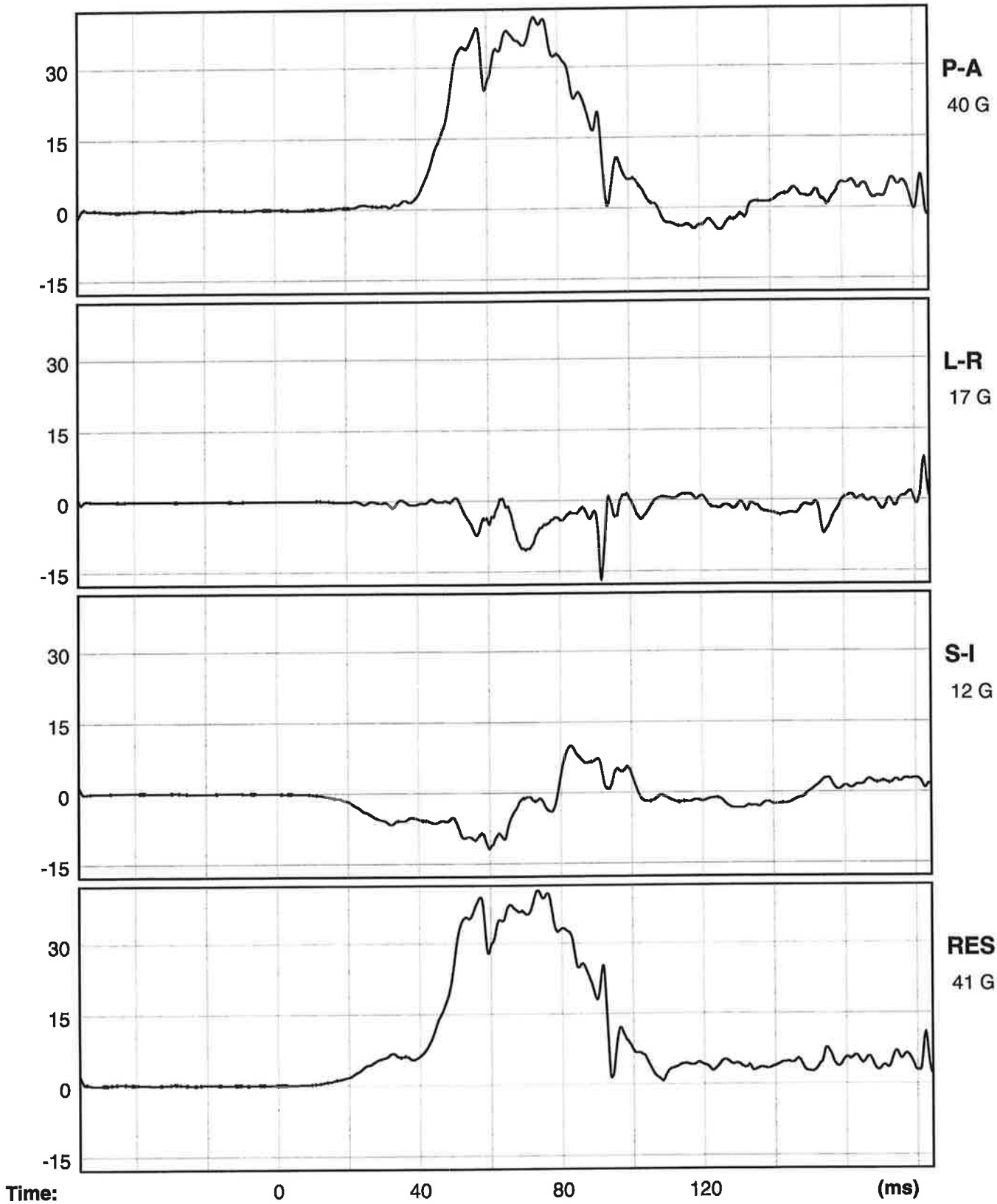
H.I.C. = 412
H.I.C. (15 ms) = 264

T1 = 58.1 ms
T1 = 72.0 ms

T2 = 109.0 ms
T2 = 87.0 ms

CHEST Accelerations

PR 0402



Clipped Peak = 40.0 G

Greater than 60 G for 0.0 ms.

BELT Loads 1

PR 0402