

Sled Impact Test

**MP 0708**  
**Sunrise Medical**

**Frontal Impact of J3 Model PASH Seatback and 16" Iris Seatpan Assembly  
Installed on the ISO/RESNA Surrogate Wheelchair Base (SWCB)  
Secured by a Surrogate Four-Point, Strap-Type Tiedown  
And Loaded with a Hybrid III Midsize-Male ATD  
Restrained by a Surrogate Vehicle-Anchored Three-Point Belt**

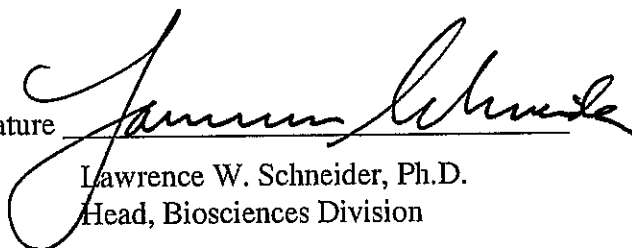
This test was conducted in accordance with draft standards  
ISO 16840-4 and Section 20 ANSI/RESNA WC/Volume 4,  
*Wheelchair Seating Systems for Use in Motor Vehicles*  
that are currently under development

Test Date: July 25, 2007

Submitted to:  
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Authorized Signature



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## ACKNOWLEDGEMENT AND TEST PURPOSE

This test was sponsored by the Sunrise Medical of Longmont, Colorado and was conducted in accordance with procedures in Annex A of ISO 16840-4 and Annex A of Section 20, ANSI/RESNA WC/Volume 4, *Wheelchair Seating Systems for Use in Motor Vehicles* that are now under development. The wheelchair seating system's performance has been measured and evaluated according to the requirements of 5.1.1 of these standards. Advertisements and marketing literature should refer to the requirements and provisions of ANSI/RESNA WC20, 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. 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 Sunrise Medical J3 model PASH seatback and 16" Iris seatpan assembly were installed on the ISO/RESNA surrogate wheelchair base (SWCB), which was placed on the sled platform facing forward and secured using the surrogate four-point, strap-type tiedown specified in Section 19 ANSI/RESNA WC/Volume 1 *Wheelchairs Used As Seats in Motor Vehicles*. The adjustable width of the SWCB was set to 15-inches prior to testing. The attachment hardware of the seating system was fitted to the seatback rails and seat canes of the SWCB, and the seatback height was adjusted according to the manufacturer's instructions. The front tiedown straps were hooked to the securement points provided on the front of the SWCB and the rear securement hooks were attached to the lower securement points at the back of the SWCB.

The seating system was loaded with a Hybrid III midsize male anthropomorphic test device (ATD) that was restrained by a surrogate vehicle-anchored three-point belt. The left end of the lap belt was anchored to the sled platform behind and to the left 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 D-ring anchored to the sled platform behind and to the right side of the wheelchair. 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 ATD rebound kinematics and response of the J3 model PASH seatback when installed on the SWCB with a 16" Iris seatpan assembly. The following table provides further details about the test equipment and setup.

## SUMMARY OF TEST SETUP AND PRE-TEST MEASUREMENTS

<p><b>GENERAL TEST INFORMATION</b></p> <p>Test number Test date Seating System</p> <p>Wheelchair type Wheelchair tiedown</p> <p>Occupant restraint Anthropomorphic Test Dummy (ATD) Wheelchair orientation Sled platform Desired impact velocity (<math>\Delta V</math>) Desired average sled deceleration</p>	<p>MP 0708 July 25, 2007 J3 model PASH seatback and 16" Iris seatpan assembly ISO/RESNA surrogate wheelchair base Surrogate four-point, strap-type tiedown with rear tiedowns attached to lower securement points Surrogate vehicle-anchored three-point belt Hybrid III 50th Male ATD @ 77 kg (170 lb) Forward facing Rigid steel plate 48 kph (30 mph) 20 g</p>
<p><b>WHEELCHAIR TIEDOWN</b></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>381 mm (15.0 in) 38 degrees 0 degrees 425 mm (16.8 in) 495 mm (19.5 in)</p> <p>699 mm (27.5 in) 42 degrees 18 degrees 533 mm (21.0 in)</p>
<p><b>OCCUPANT RESTRAINT</b></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) 1270 mm (50.0 in) 305 mm (12.0 in) 56 degrees</p> <p>56 degrees, measured on ATD torso 30 degrees, measured above ATD shoulder</p> <p>483 mm (19.0 in) 51 mm (2.0 in)</p>
<p><b>ATD POSITIONING</b></p> <p>Shoulder height above sled platform H-point height above sled platform</p>	<p>1092 mm (43.0 in) 610 mm (24.0 in)</p>
<p><b>WHEELCHAIR</b></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>53.6 kg (118 lb) 533 mm (21.0 in) 9 degrees 610 mm (24.0 in) 6 degrees 546 mm (21.5 in) 445 mm (17.5 in)</p>
<p><b>POSTURAL SUPPORT DEVICES</b></p>	<p>None</p>

## TEST RESULTS

The J3 model PASH seatback and 16" Iris seatpan assembly remained attached to the ISO/RESNA surrogate wheelchair base at all attachment points during impact loading and the maximum forward excursion of point P on the wheelchair seating system was 39 mm, which is below the WC20 proposed excursion limit of 200 mm. After the test, the SWCB was upright on the sled platform and the ATD was seated in the wheelchair seat with the torso leaning approximately 5° to the left. The ATD could be removed from the belt restraint without the use of tools.

The ATD was effectively restrained from forward excursion by the surrogate vehicle-anchored three-point pelvic and shoulder belt during impact. Peak forward head excursion was limited to approximately 315 mm and peak forward knee excursion was limited to about 217 mm, which are both below the WC20 proposed limits of 650 mm and 375 mm, respectively. The ratio of the ATD's knee excursion to the wheelchair point-P excursion is 5.5, which is above the minimum required ratio of 1.1. The ATD's head traveled 445 mm rearward of its initial position during the test, which is just below the WC20 proposed limit of 450 mm. The ATD's post-test H-point height did not change from the pre-test height.

The results of this test show that the Sunrise Medical J3 model PASH seatback and 16" Iris seatpan assembly installed on the ISO/RESNA SWCB meets all criteria for wheelchair seating systems proposed in Section 5.1.1 of ISO 16840-4 and Section 20, ANSI/RESNA WC/Volume 4. The following tables summarize the test results and compliance with these standards.

## SUMMARY OF TEST RESULTS

<b>GENERAL TEST INFORMATION</b> Test number Actual impact velocity ( $\Delta V$ ) 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	MP 0708 48 kph (30.1 mph) 19.7 ms 23.9 ms 24.7 ms 59.1 ms 81.9 ms
<b>ATD MEASUREMENTS</b> Peak resultant head acceleration Peak resultant chest acceleration Head injury criteria (unlimited) Maximum forward head excursion <sup>†</sup> Maximum forward knee excursion <sup>††</sup> Maximum rearward head excursion <sup>††</sup> Average post-test H-pt ht above sled platform	53 g 46 g 239 315 mm (12.4 in) 217 mm (8.6 in) 445 mm (17.5 in) 610 mm (24.0 in) 0% change
<b>TIEDOWN LOADS</b> Peak left-rear tiedown strap force Peak right-rear tiedown strap force	14394 N (3236 lb) 13345 N (3000 lb)
<b>BELT LOADS AND PELVIC BELT ANGLE</b> Peak left pelvic-belt load Peak shoulder-belt load Post-test pelvic restraint angle	8016 N (1802 lb) 11263 N (2532 lb) 52 degrees
<b>WHEELCHAIR MEASUREMENTS<sup>††</sup></b> Maximum forward wheelchair excursion at Point P* Maximum forward excursion of front-wheel hub Maximum forward excursion of rear-wheel hub	39 mm (1.5 in) 77 mm (3.0 in) 71 mm (2.8 in)

<sup>†</sup>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.

<sup>††</sup>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 SEATING SYSTEM PERFORMANCE PER PRELIMINARY  
CRITERIA in ISO 16840-4 and SECTION 20 OF ANSI/RESNA WC/VOLUME 4**

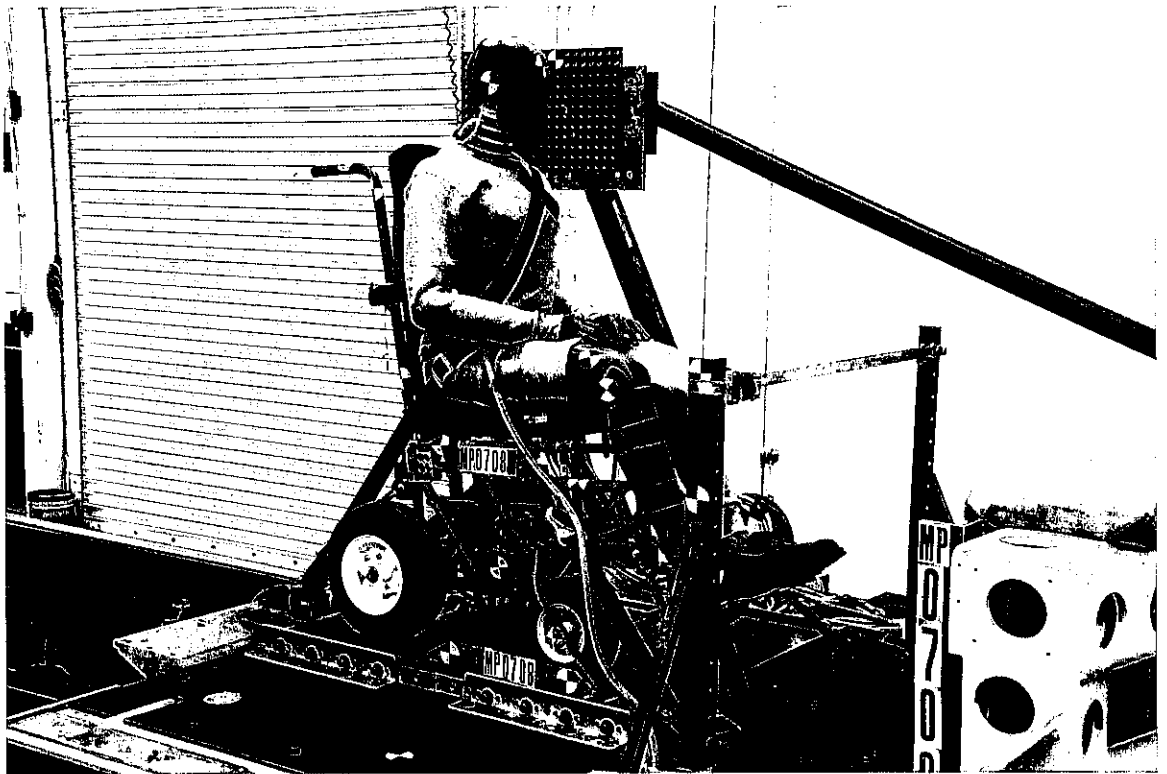
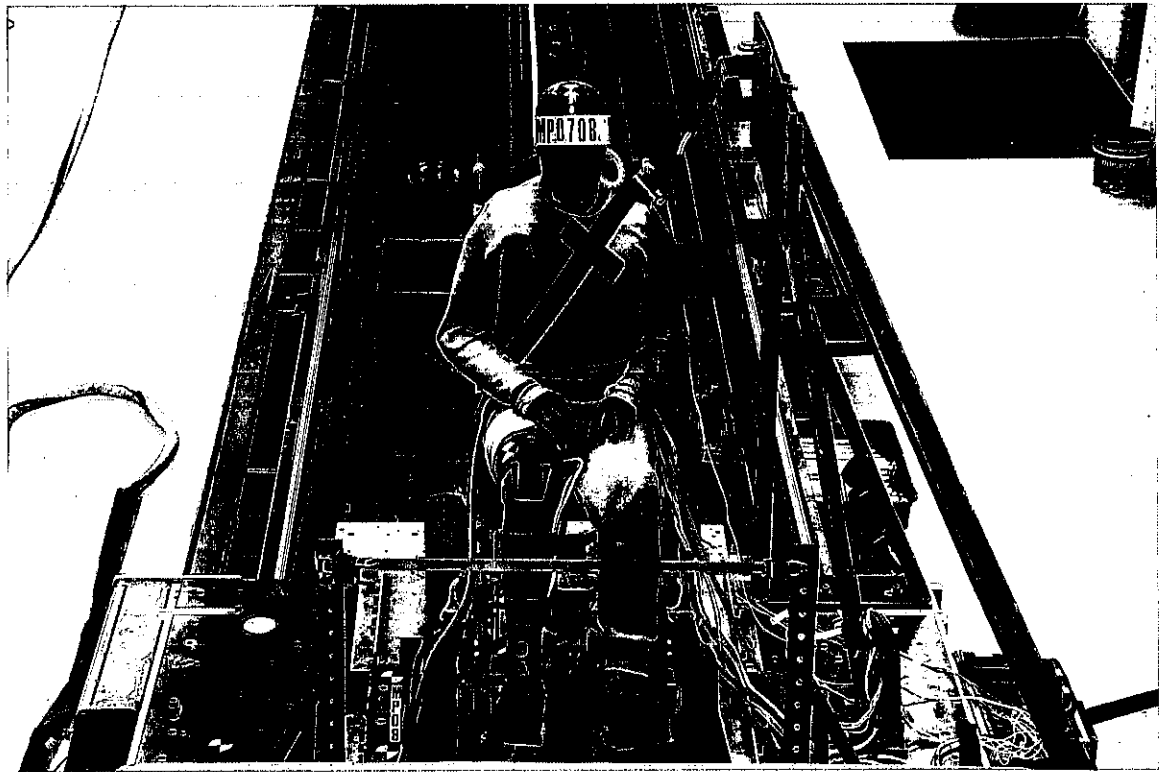
**SLED TEST MP 0708**

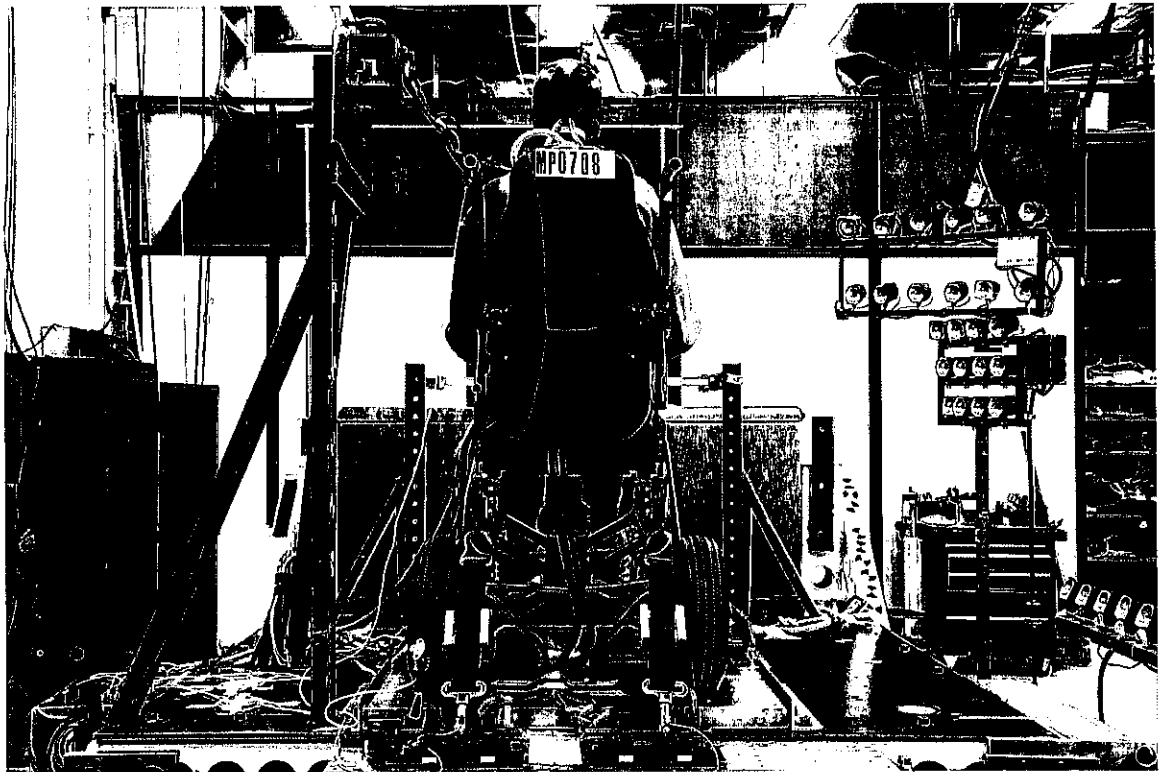
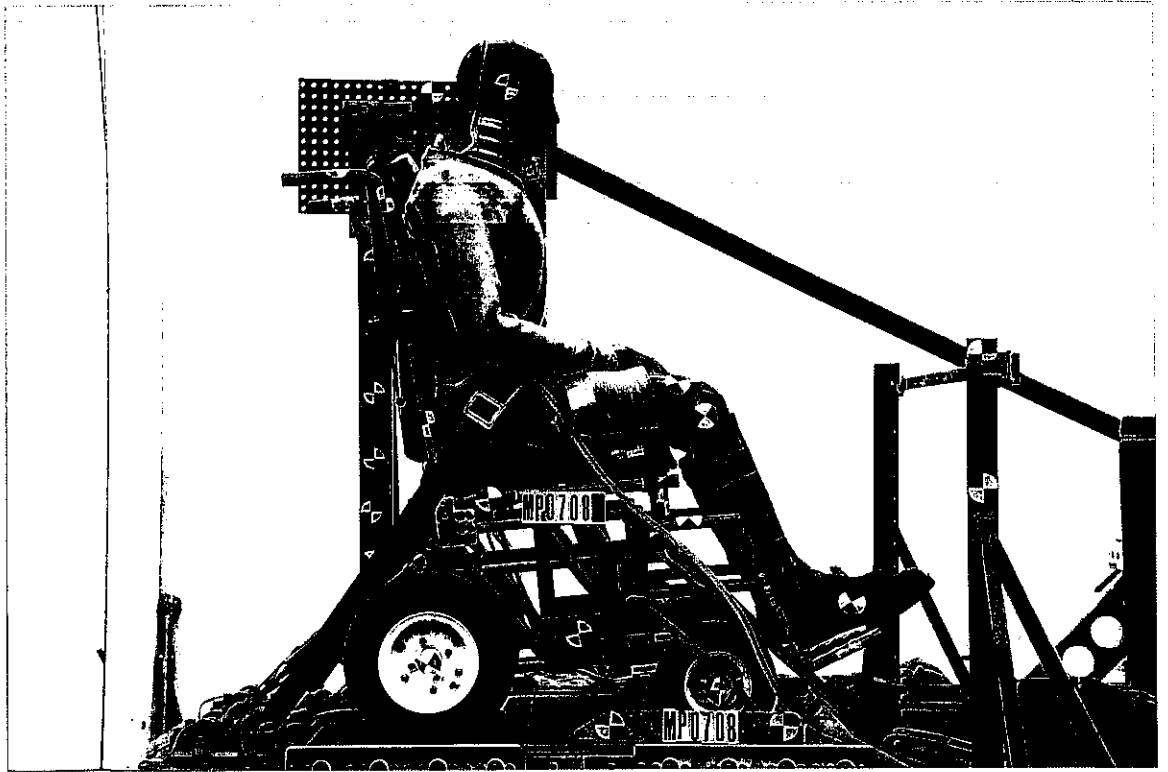
Requirement		Observed Performance	
WC20 Clause (ISO 16840-4)	Description	Description	Pass/Fail
5.1.1a (5.1.1a)	Forward excursion of Point P < 200 mm	39 mm	Pass
	Forward knee excursion < 375 mm	217 mm	Pass
	Forward head excursion < 650 mm	315 mm	Pass
	Rearward head excursion < 450 mm	445 mm	Pass
5.1.1b (5.1.1b)	Ratio of ATD knee excursion to Point P excursion must exceed 1.1.	Ratio of ATD knee excursion to Point P excursion = 5.5	Pass
5.1.1d (5.1.1d)	Seating system shall not completely separate from the SWCB at any attachment point	Seating remained attached to SWCB at all attachment points	Pass
5.1.1e (5.1.2a)	ATD must be in WC seat with torso reclined not more than 45°	ATD in WC seat with torso leaning about 5° to the left	Pass
5.1.1f (5.1.2b)	Primary load-carrying components of the seating system and attachment hardware cannot show visible signs of structural failure	No primary load-carrying components failed	Pass
5.1.1g (5.1.2c)	Detached seating hardware cannot exceed 100g	No hardware detached from the seating system	Pass
5.1.1h (5.1.2d)	Seating system components must not have sharp edges with potential for occupant contact	No sharp edges	Pass
5.1.1i (5.1.2e)	Post-test height of ATD H-point shall not be more than 20% lower than pretest height	ATD H-point height did not change	Pass

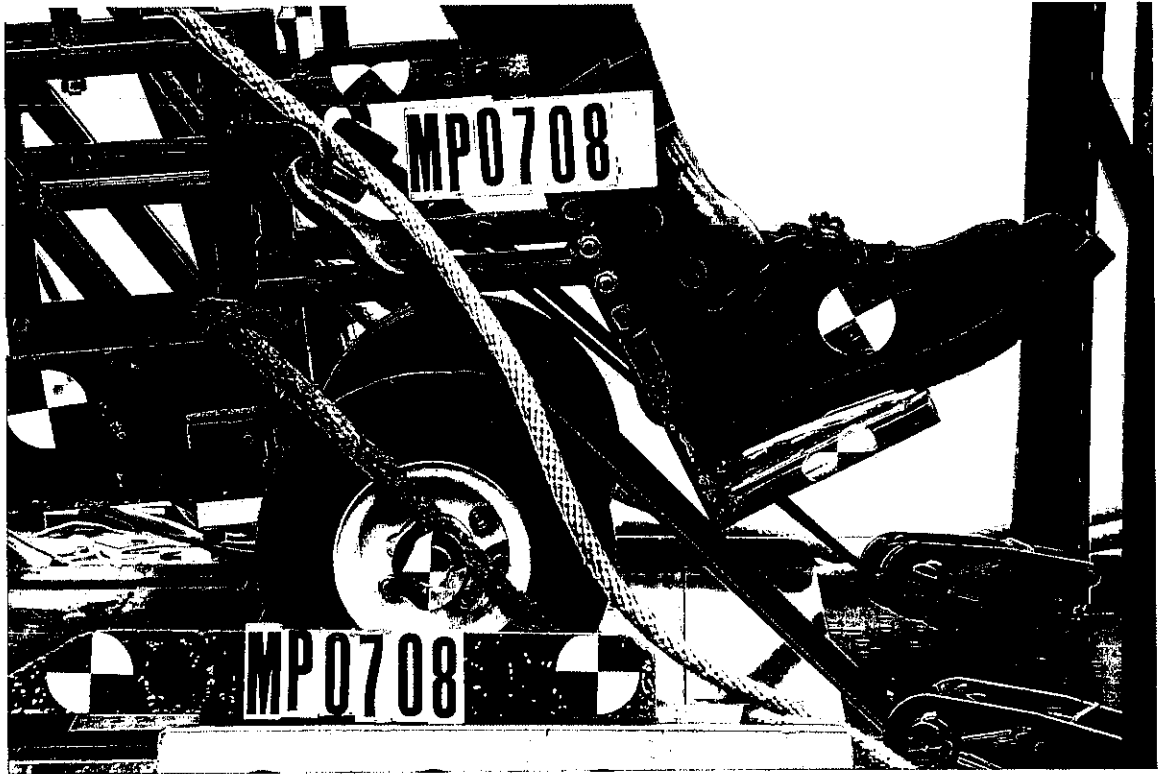
Note: SWCB = surrogate wheelchair base

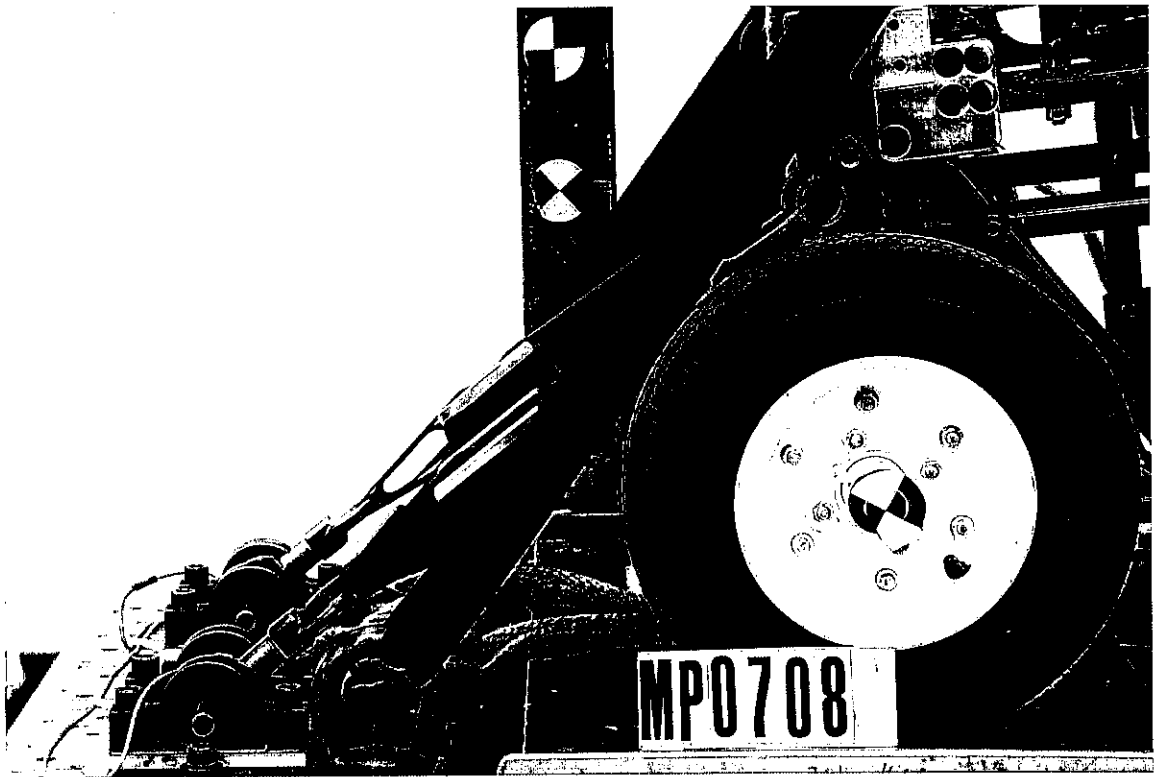
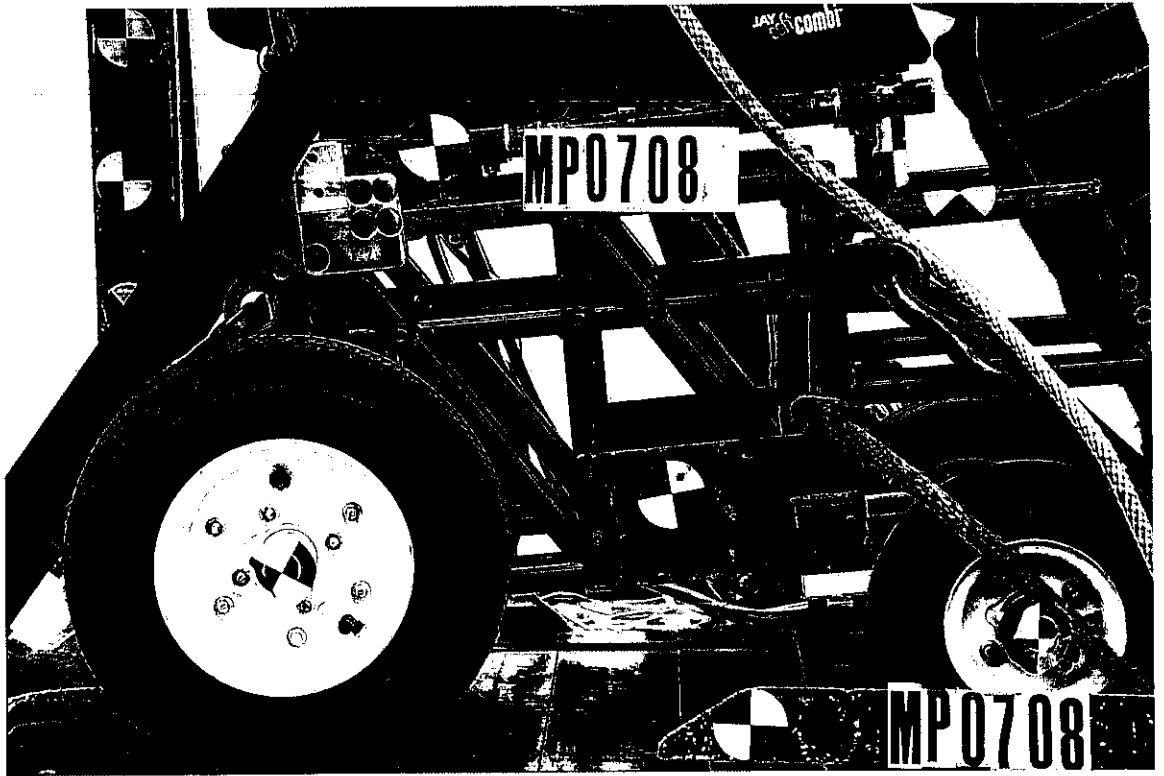


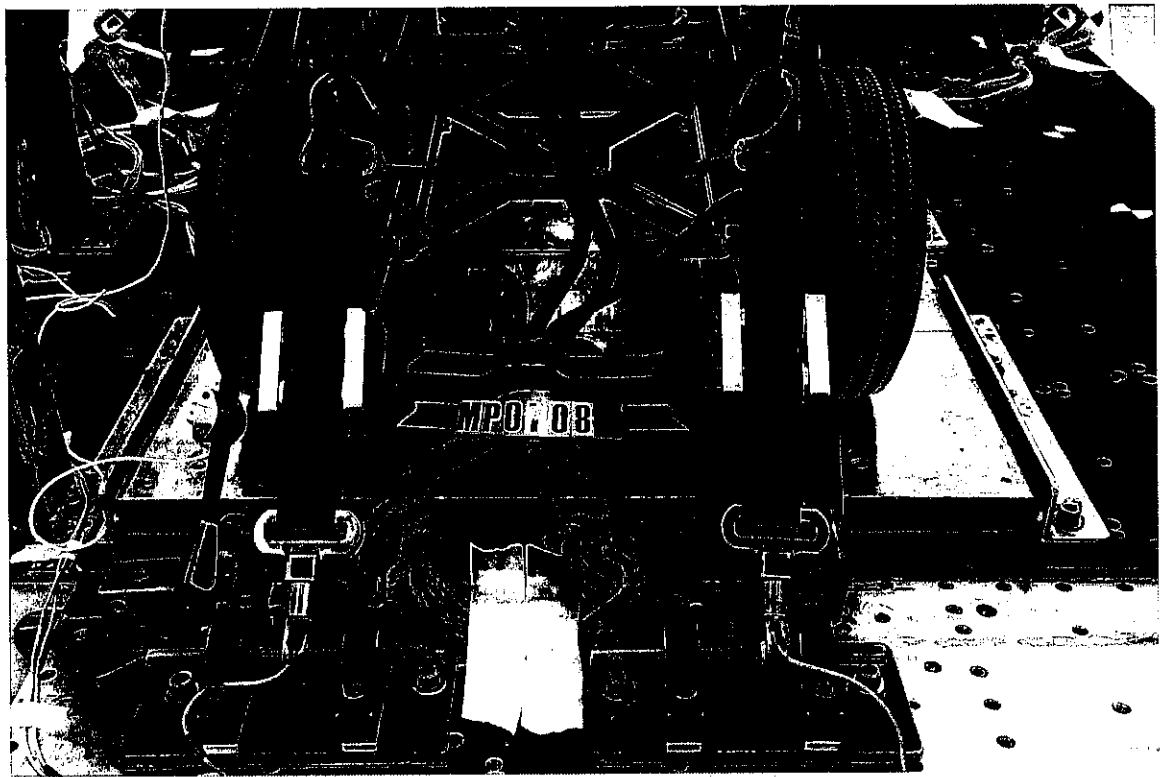
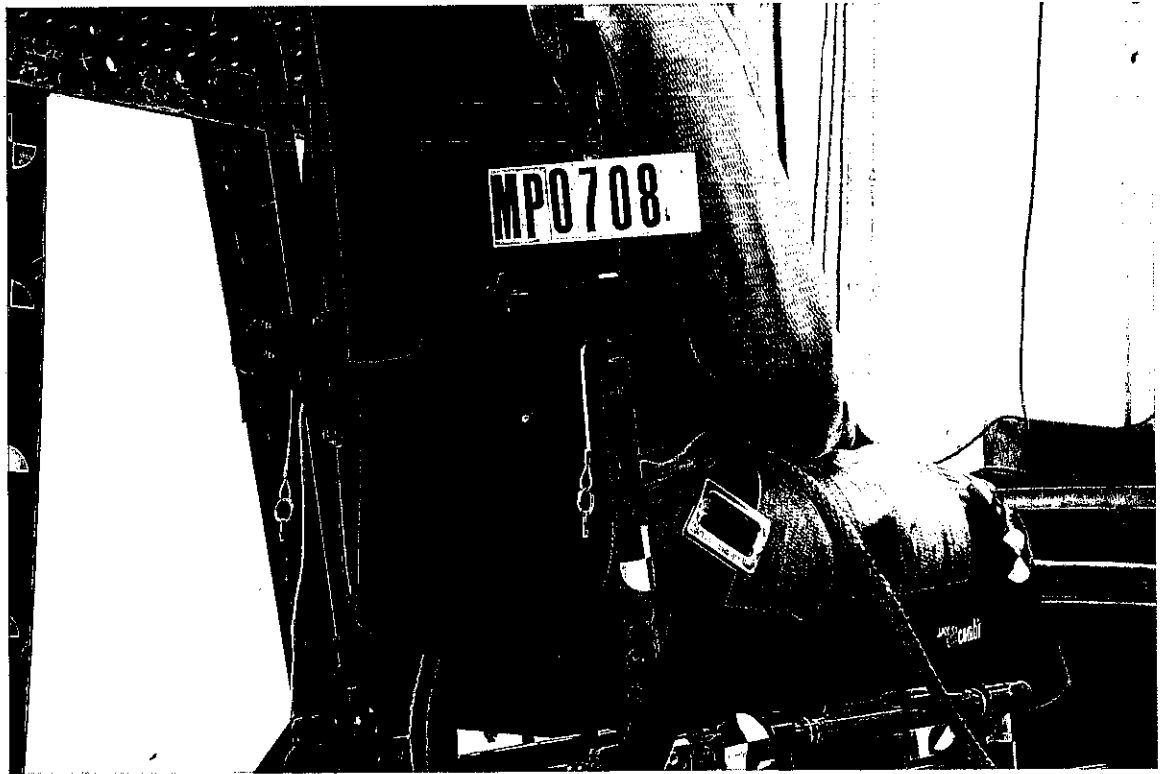
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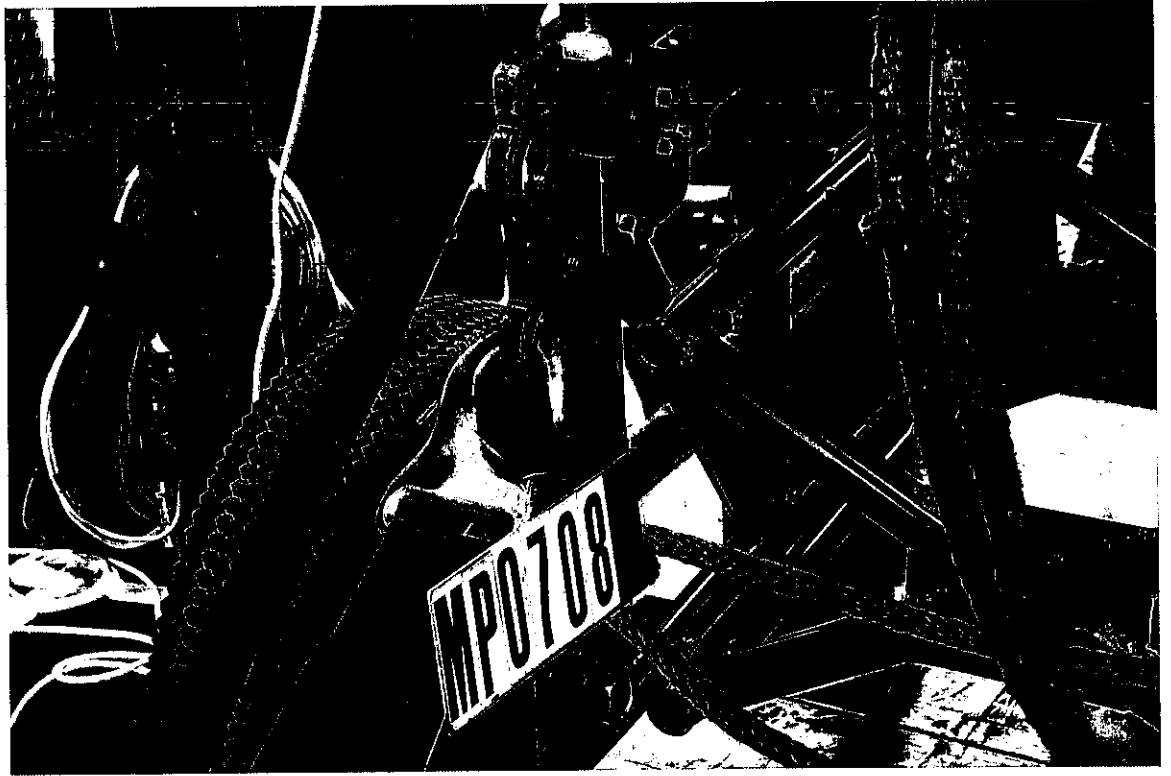










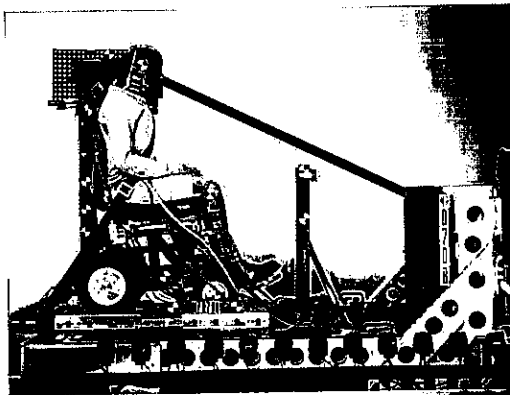


**TEST AND POST-TEST PHOTOS**

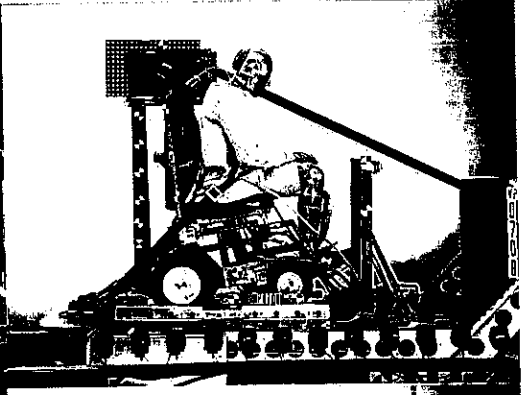


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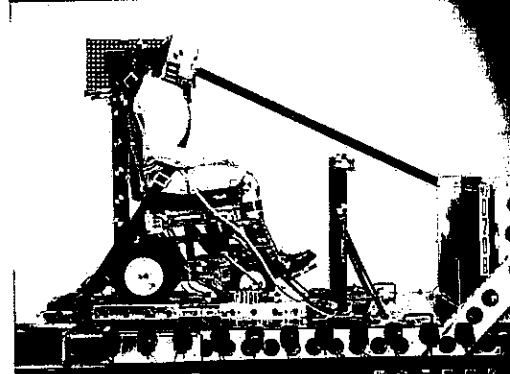
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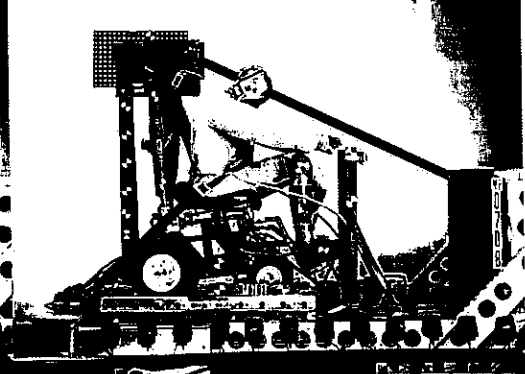
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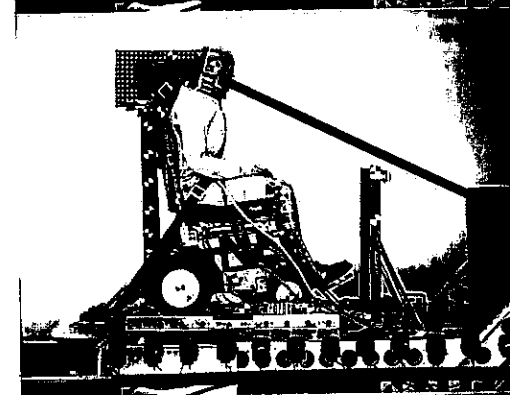
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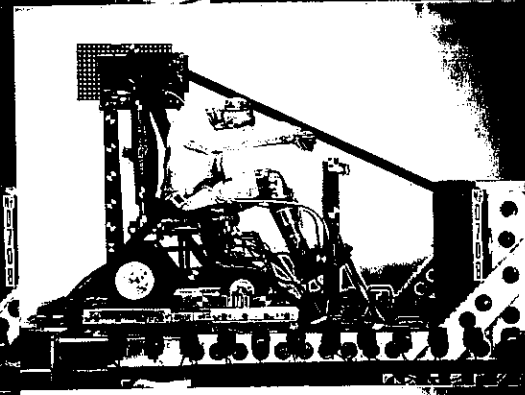
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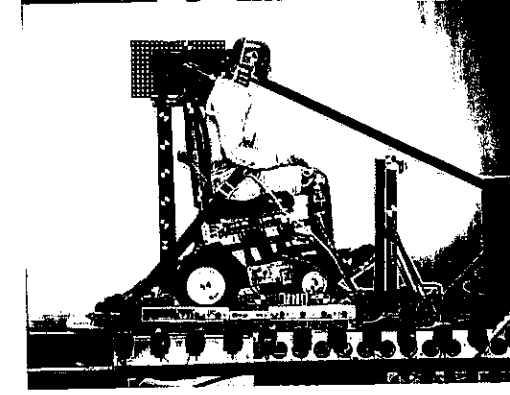
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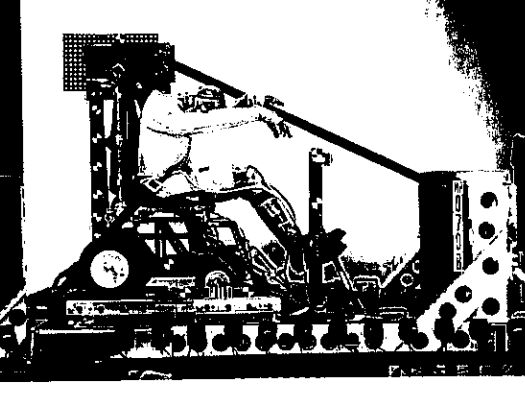
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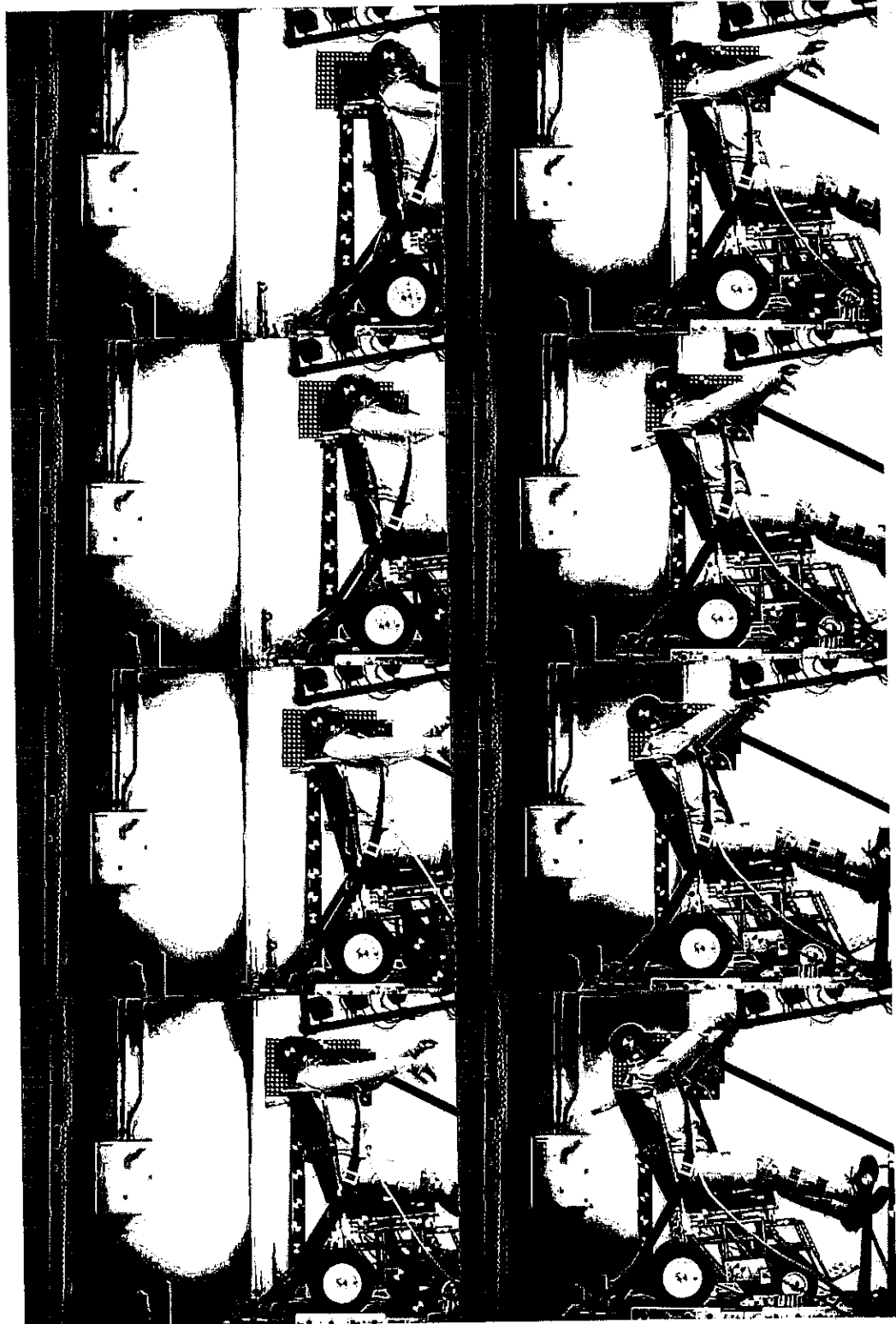
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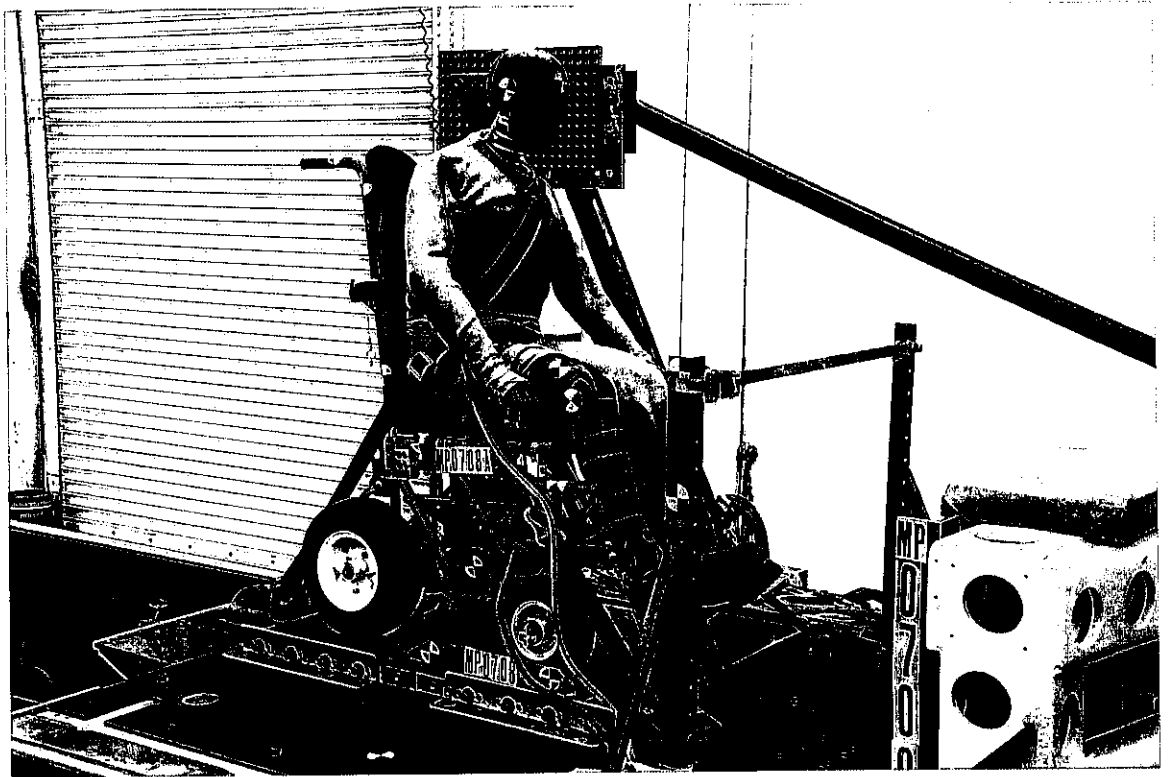
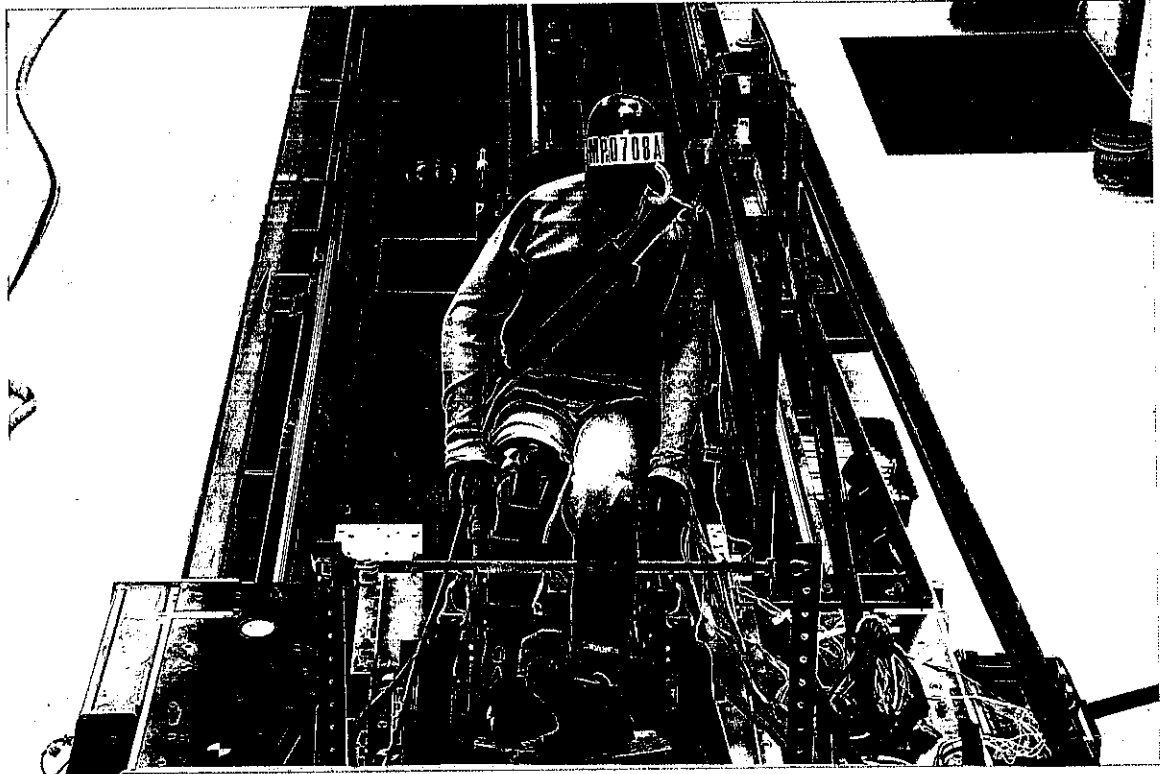


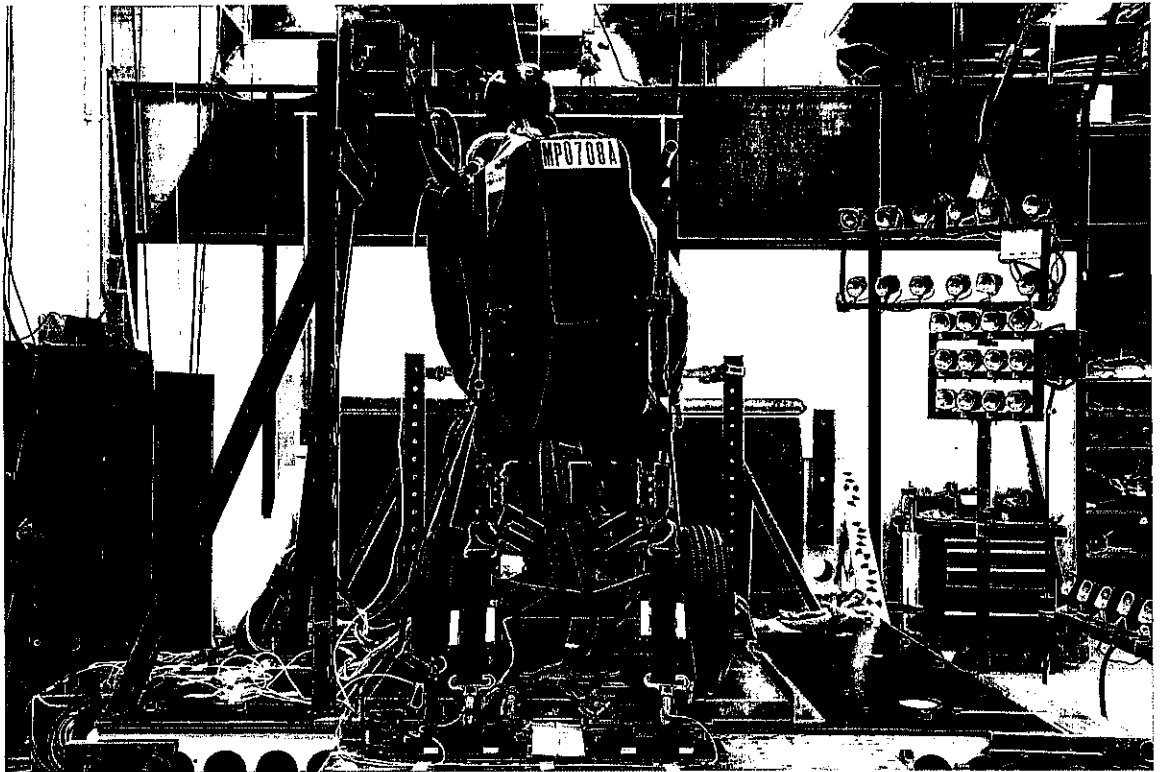
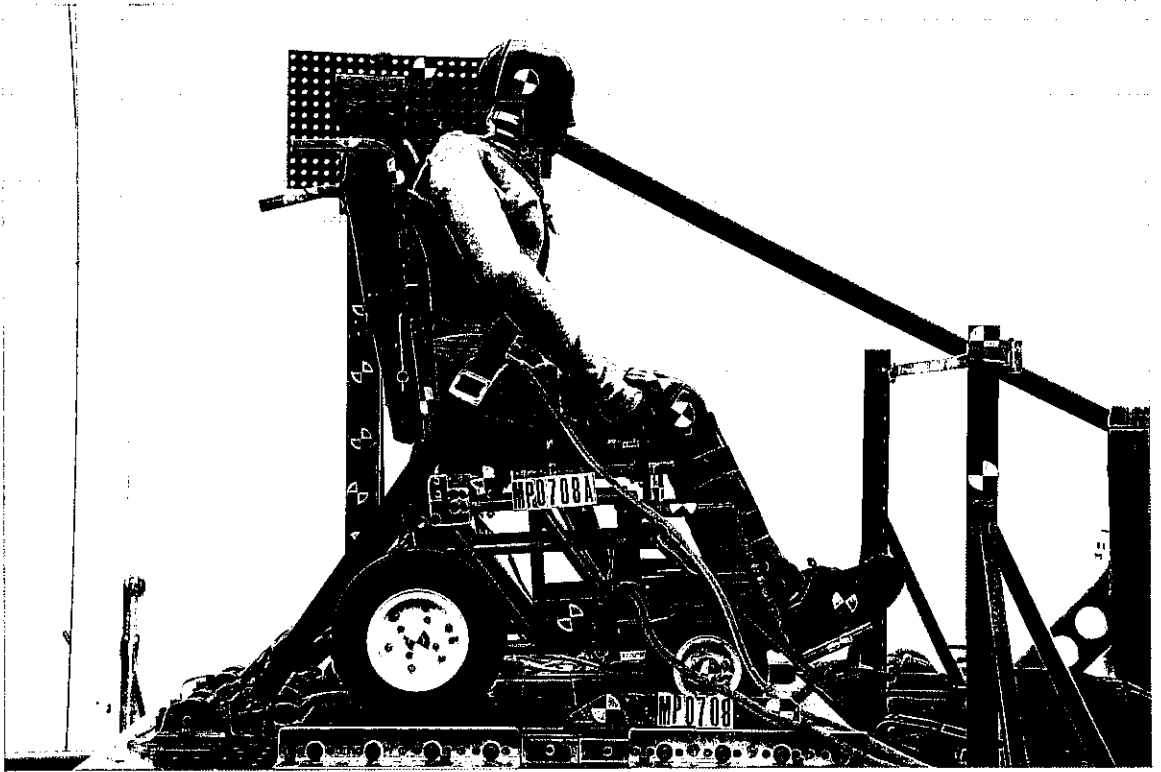
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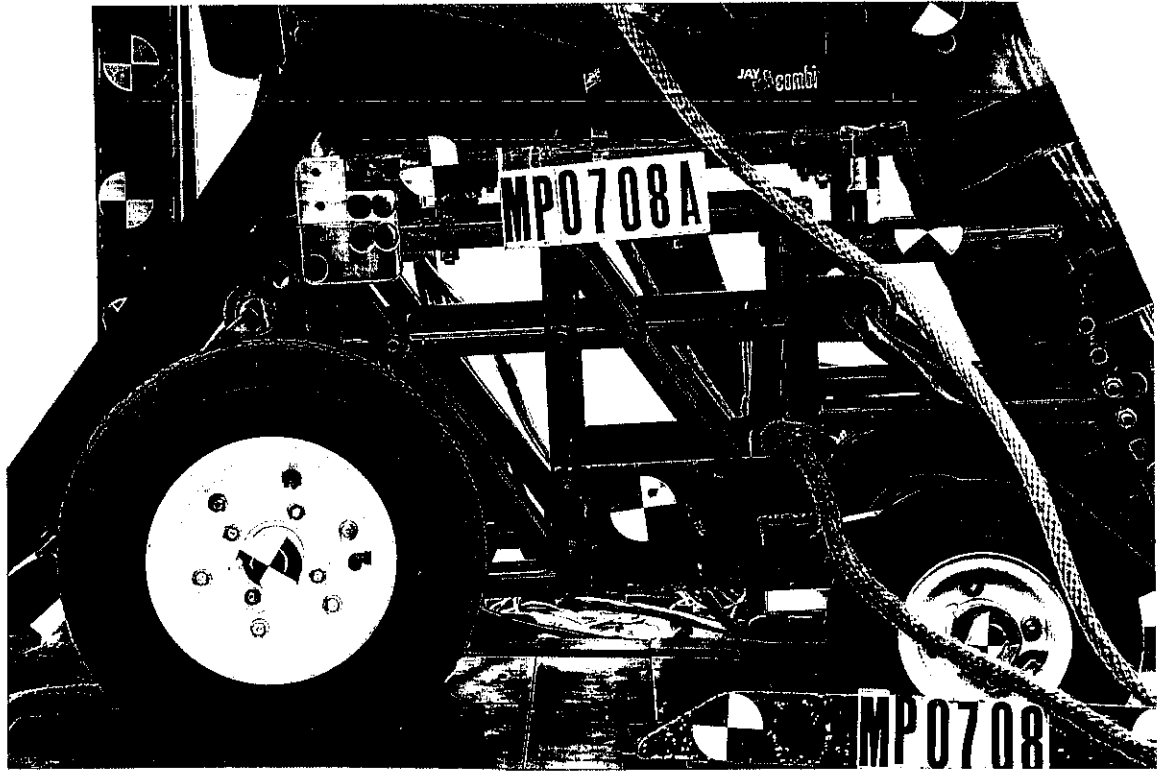
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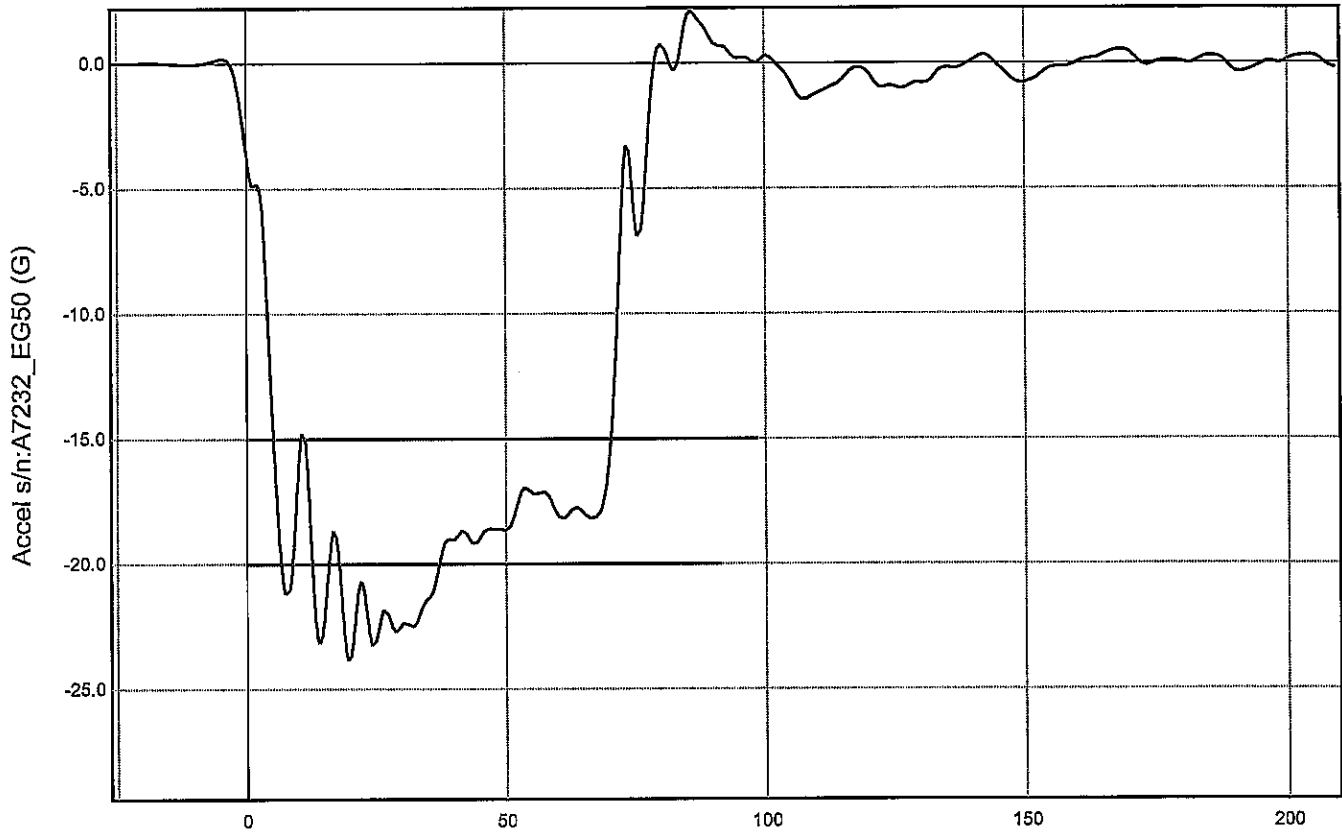
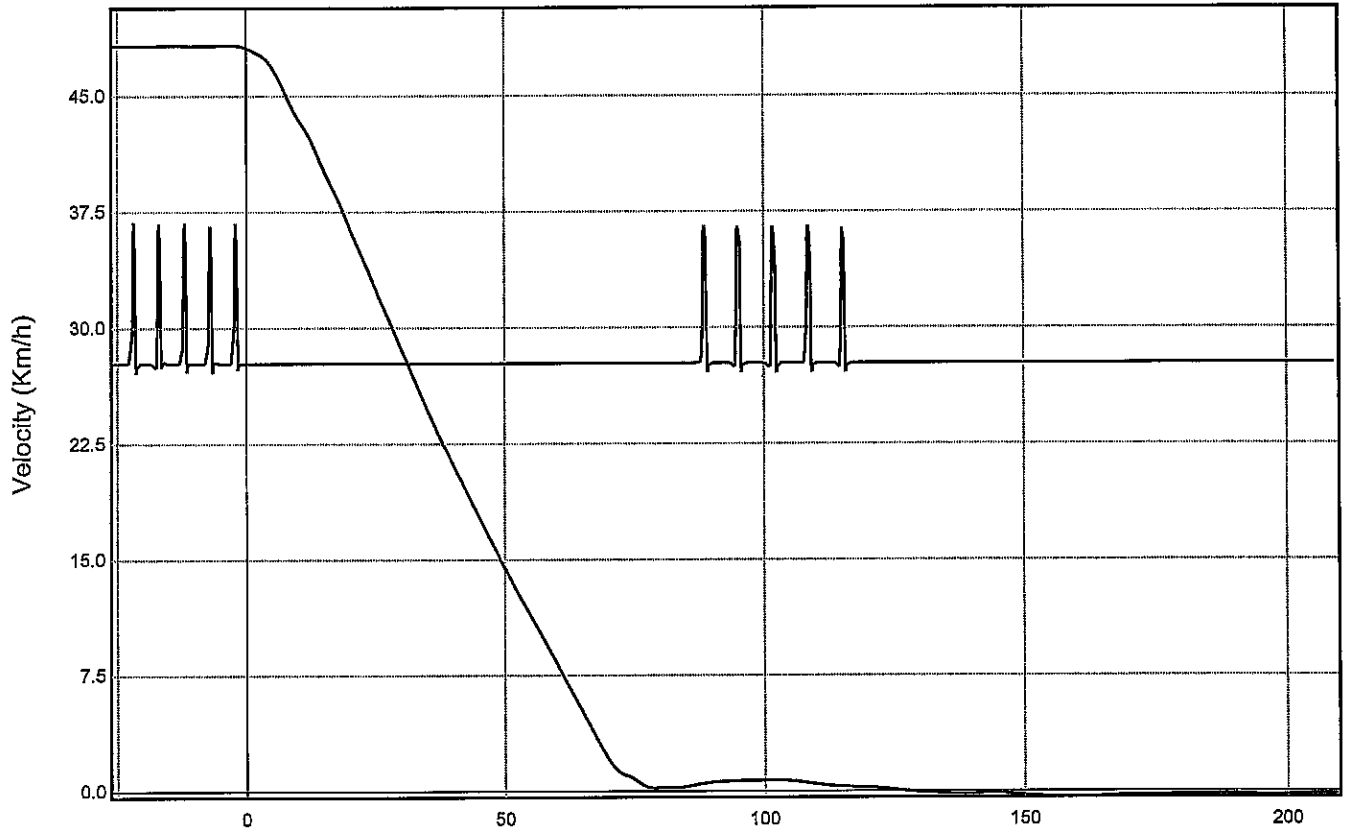






**TEST SIGNALS**





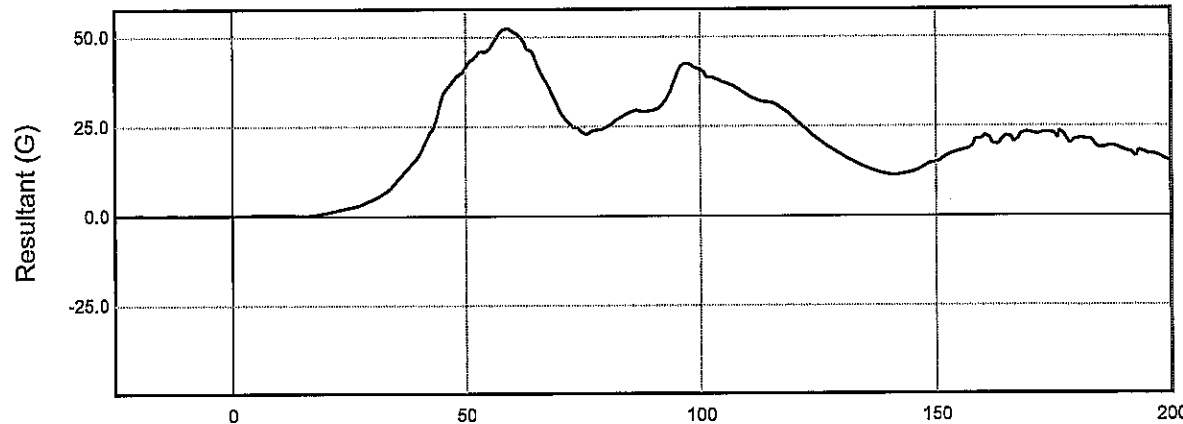
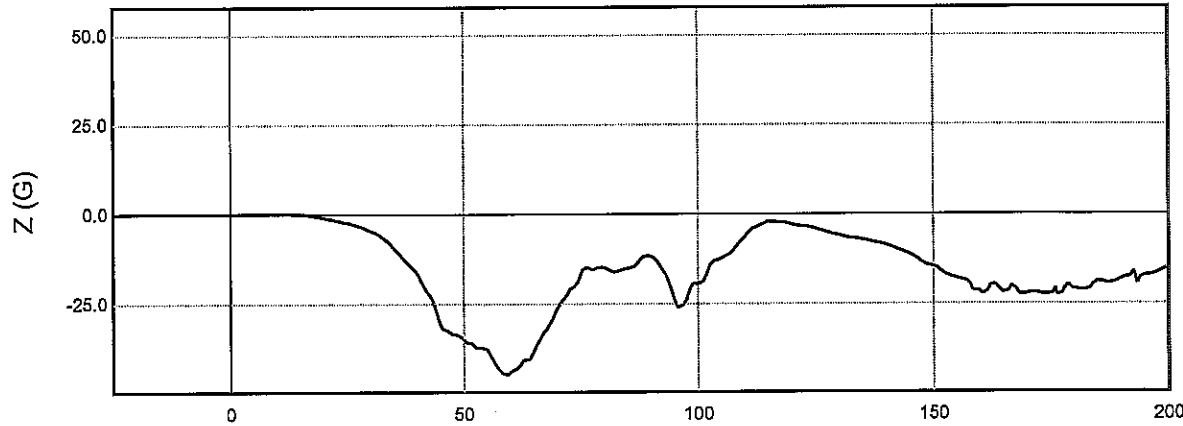
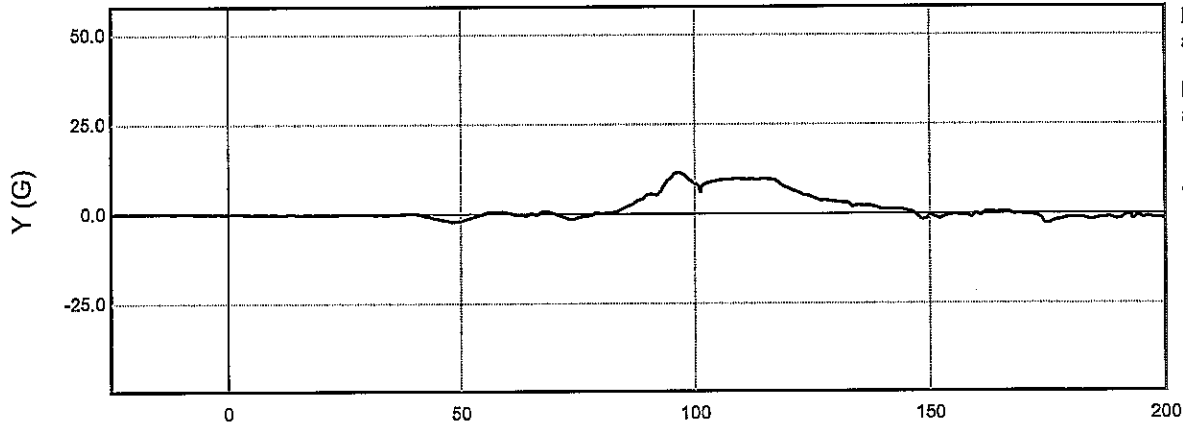
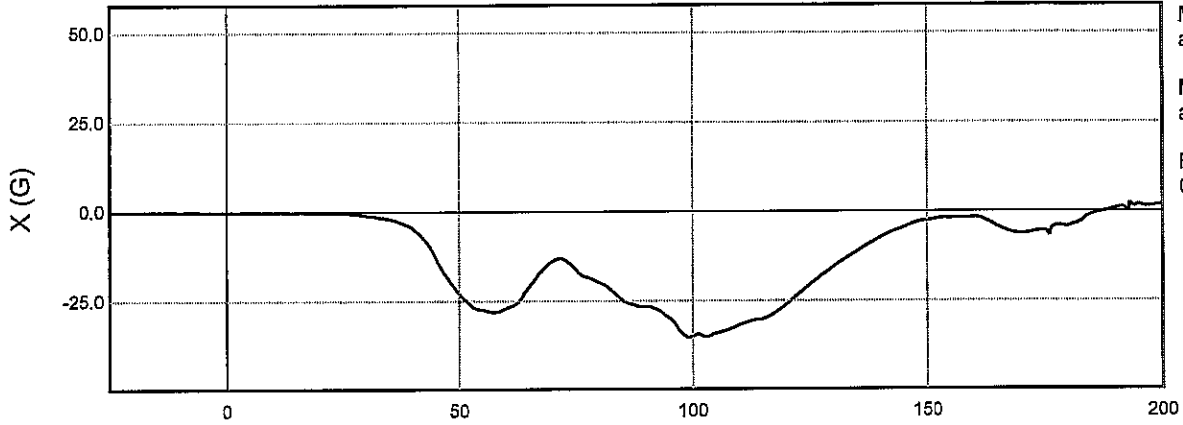
Sled Pulse Duration = 81.9 ms  
Sled Plateau Average Level = -19.7 G  
Sled Decel Peak = -23.9 G  
Total time under -20.0 G was 24.7 ms  
Continuous time under -15.0 G was 59.1 ms

Efficiency =  $V_{out} / V_{in} = 20.71 / 27.71 = 74.7\%$   
Sled Delta V = 48.4 kph (30.1 mph)  
Stopping Dist. (est) = 0.560 m

UMTRI

Head Acceleration

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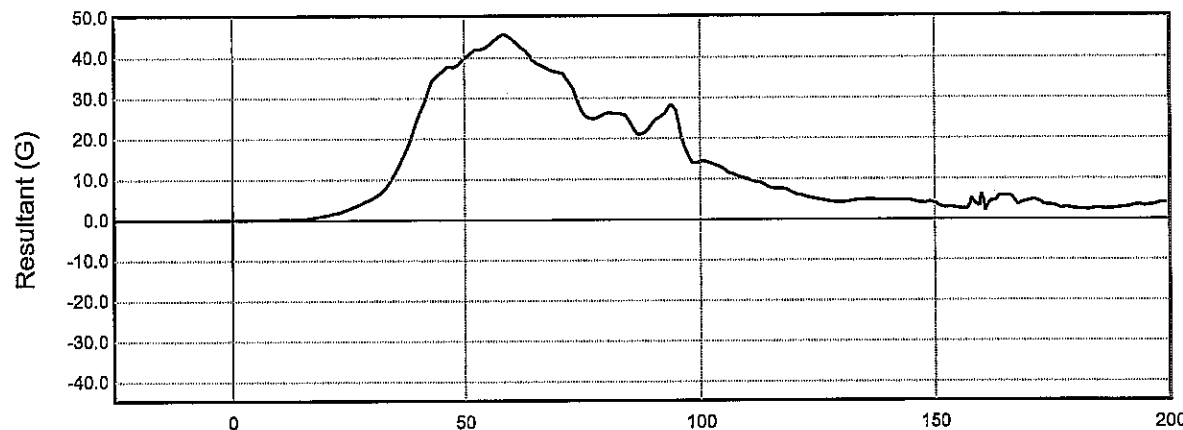
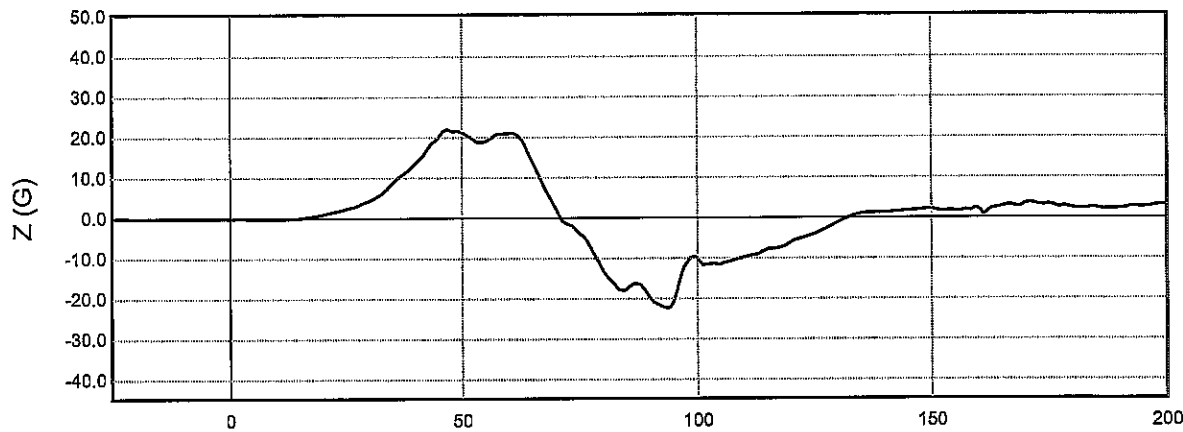
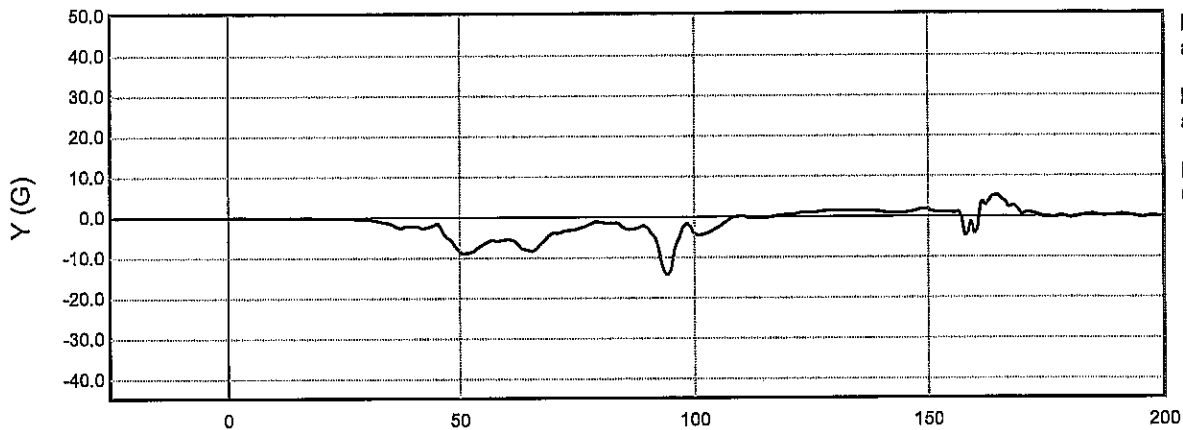
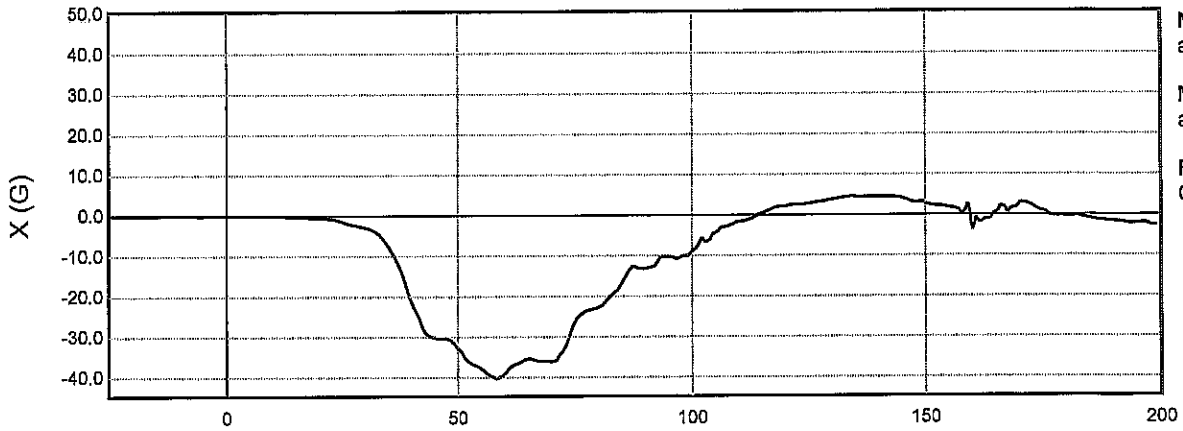


H.I.C. (UN) = 589.2 From: 39.4 to 198.3 ms  
H.I.C. (15) = 238.7 From: 50.4 to 65.4 ms

UMTRI

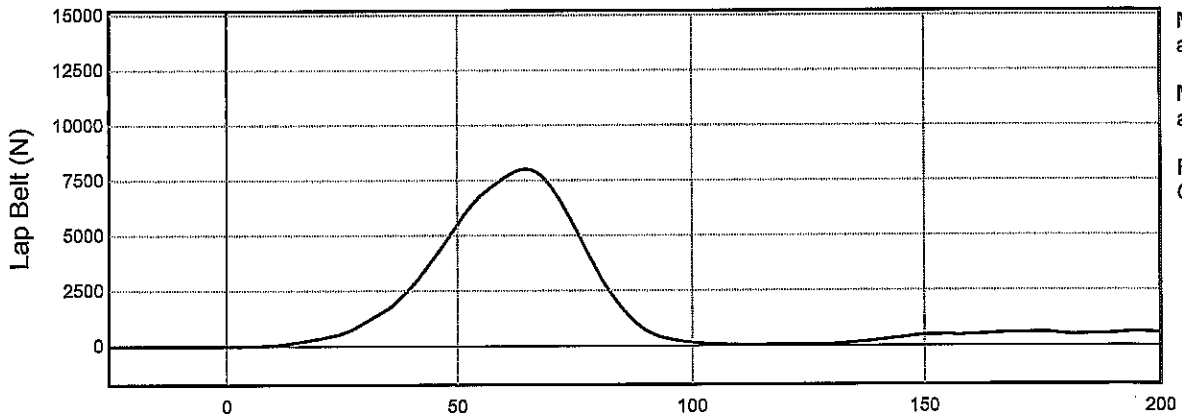
Chest Acceleration

MP0708



3.0 ms Clipped Peak = 44.8G  
Total time over 60.0 G was 0.0 ms

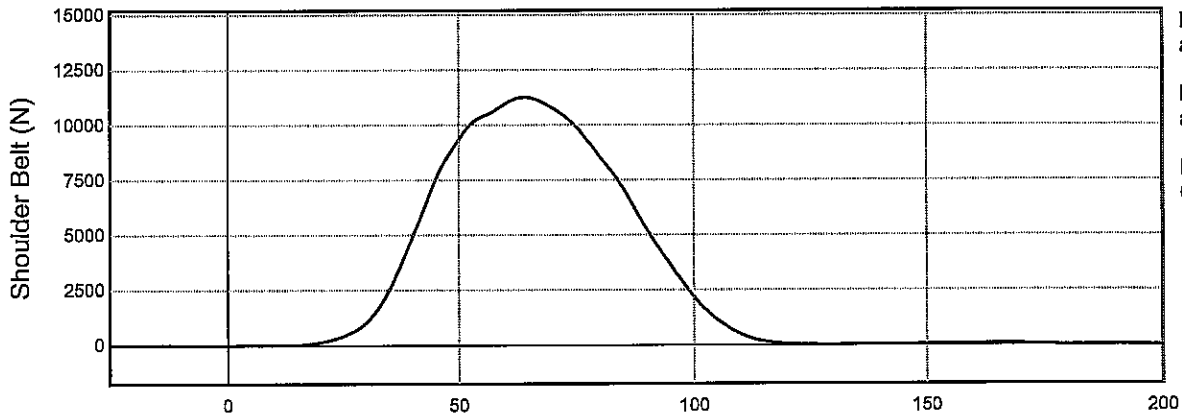
From: 57.0 to 60.0 ms



Max: 8017 N  
at 65 ms

Min: -3 N  
at 1 ms

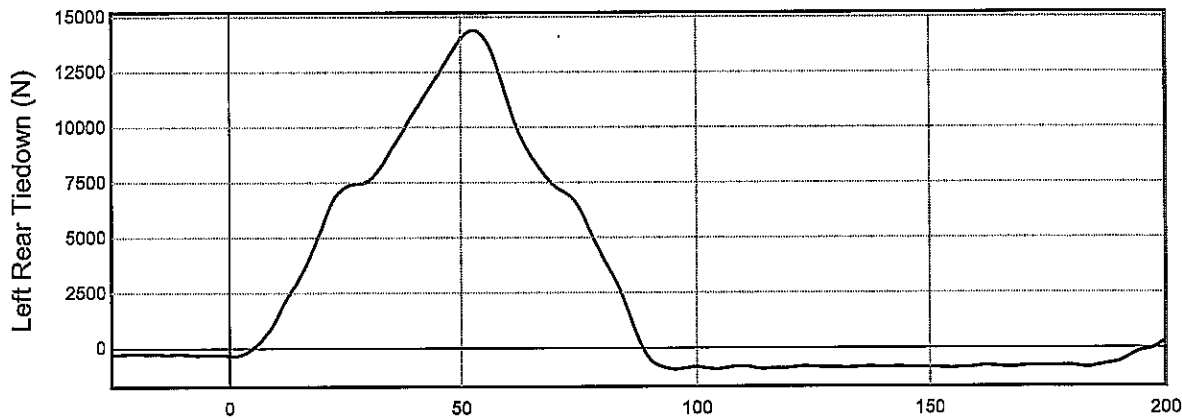
Filtered at  
CFC 60



Max: 11264 N  
at 64 ms

Min: -2 N  
at -26 ms

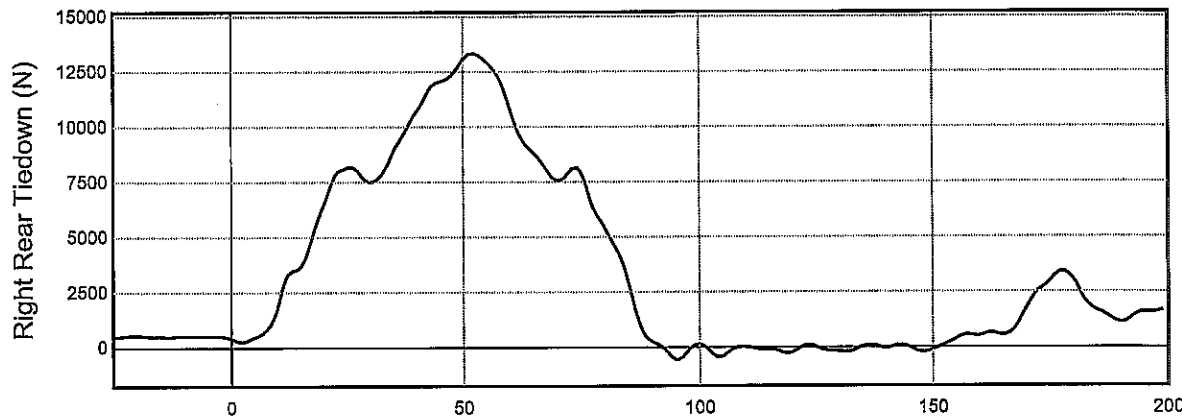
Filtered at  
CFC 60



Max: 14396 N  
at 53 ms

Min: -979 N  
at 96 ms

Filtered at  
CFC 60



Max: 13343 N  
at 52 ms

Min: -587 N  
at 95 ms

Filtered at  
CFC 60