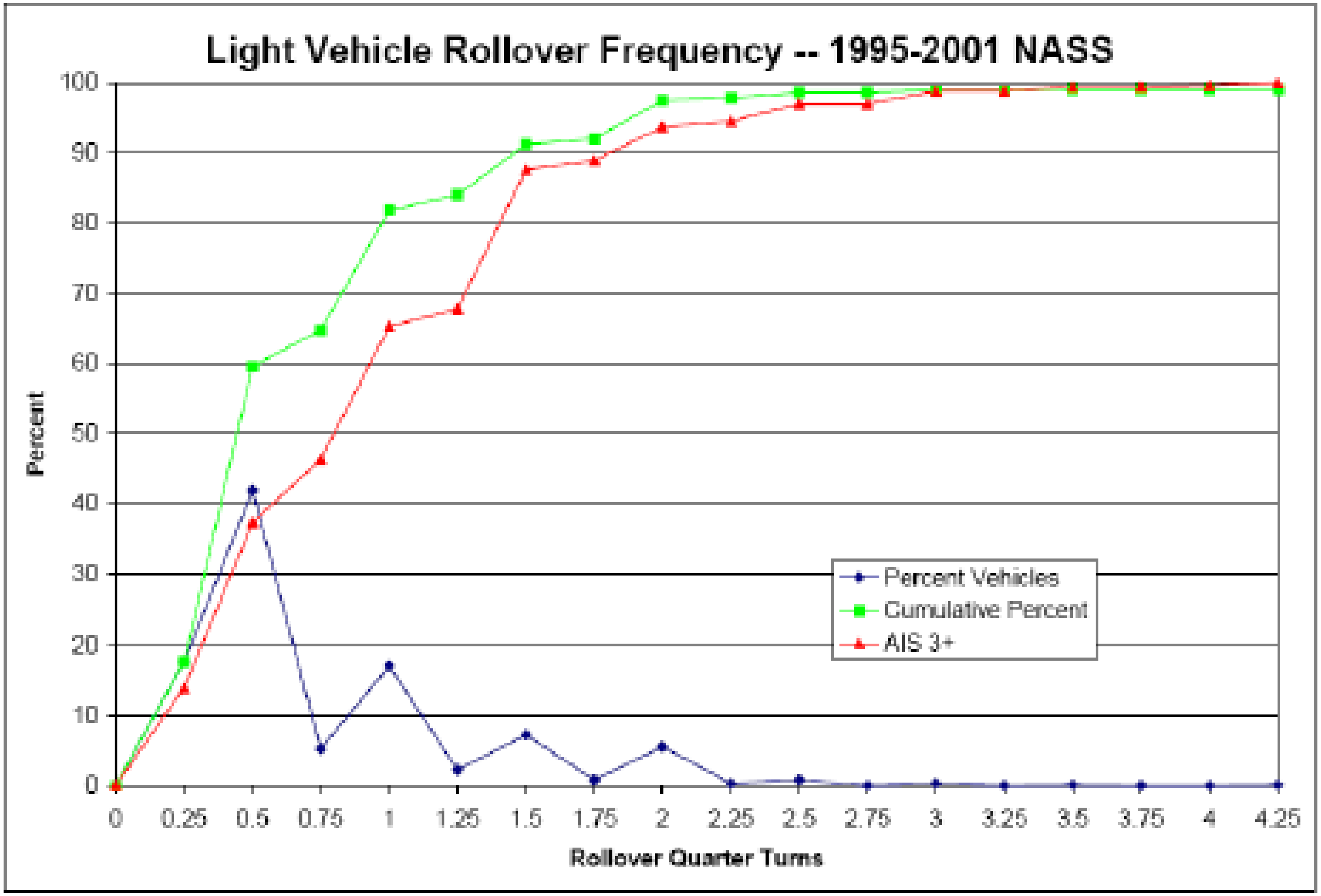
STI Safety Testing International

Donald Friedman
Susie Bozzini

Jordan Rollover System

CfIR
Center for Injury Research

Rollover frequency and AIS 3+ Injury



As much as 40% of these injuries occur in pre roll crash events, limiting the likelihood that ESC will be as effective as predicted, emphasizing occupant out of position concerns when the rollover commences.

Ejections are a Major Problem

Table 1.4 -- Fatal Glazing Ejections Annual Average for 1995-1999 NASS, Fatalities Adjusted to 1999 FARS			
	Rollover	Planar	Total
Complete Ejection	3,295	1,516	4,812
Partial Ejection	1,476	1,348	2,824
Total	4,772	2,864	7,636

Basis for JRS Dynamic Repeatable Rollover Testing

- **Malibu and Blazer Dolly Rollover Data**
- **NASS 500 Serious Injury Case Investigation Data**
- **Injury & Ejection Potential Measures**

Reference Details

- “A Study of NASS Rollover Cases and the Implication for Federal Regulation” ESV 2005 publication
- “What NASS Rollover Cases Tell Us” ESV 2007 publication
- “A Rollover Human/Dummy Head/Neck Injury Criteria” ESV 2007 publication
- “Results From Two Sided Quasi-Static (m216) And Repeatable Dynamic Rollover Tests (JRS) Relative to FMVSS 216 Tests” ESV 2007 publication
- “Human/Dummy Rollover Falling (Excursion) Speeds” ESV 2007 publication

Jordan Rollover System (JRS)

- Design Criteria
- System Functionality
- Testing Results

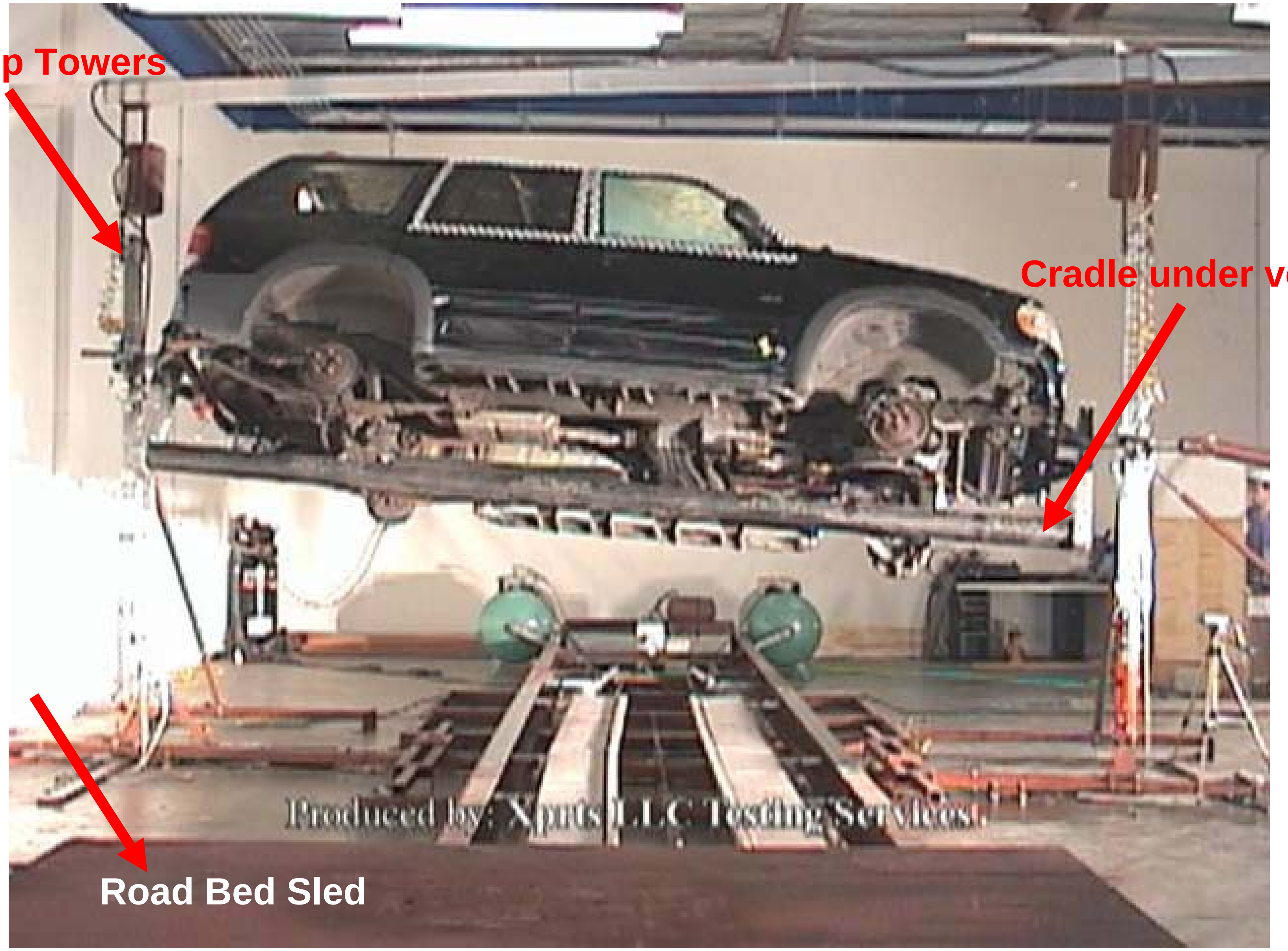
Combining 50 years of Testing Experience

- Acen Jordan has designed, built, and implemented more than 30 test sleds to testing facilities and manufacturers around the world.
- Donald Friedman has designed and tested numerous vehicles, sleds and other measurement tools over his 50 years in automotive safety.

The results of their collaboration: **The Jordan Rollover System**

- A standard pneumatic sled to be used as a road bed for the vehicle to drop on to.
- A spit - drop test rig to hold and rotate the vehicle
- Instrumentation to measure the loads on the inside of the vehicle and in the road bed.
- A control module to set testing parameters such as roll angle, roll rate and road bed speed.

Jordan Rollover System Fixture



JRS Sled Construction (road bed)

- Sled weighs 3600 pounds and is constructed of steel and aluminum
- Impact surface is an eight inch thick wooden surface covered with a grit surface that approximates the co-efficient of friction of asphalt
- Using plywood surfaces for testing is common practice in automotive industry and testing facilities

JRS Sled Construction (road bed)

- Sled is inertially matched to vehicle
- The sled provides the translational velocity that a vehicle has when rolling over in the field
- The sled slows down when the vehicle impacts it because a vehicle rolling in the field converts its translational velocity in to rotational velocity when it contacts the ground

JRS Drop Tower Construction

- Towers are fixed, yet expandable to fit different vehicle sizes
- Towers fitted with vehicle cradle for rotation in impact event
- Towers have brakes to “catch” the vehicle after the impact event, so it maintains and isolates the test result deformation

Data Acquisition Systems

- Industry-standard data measurement and acquisition system is used to collect data from the sled and vehicle:
  - More than two dozen data channels are recorded from the sled, vehicle and Hybrid III dummy

- GMC uses the same data acquisition system at it rollover test facility

Vehicle and Crash Test

JRS Phase I Research Testing Series

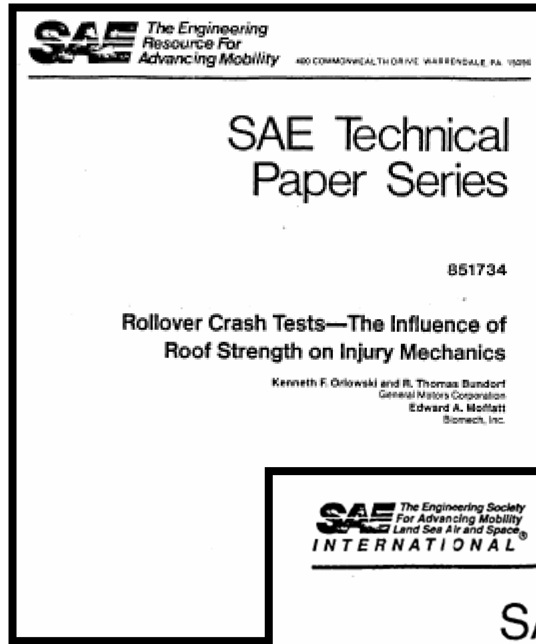
JRS Initial Impact Conditions Criteria

JRS Impact Conditions

- Derived directly from GM's own reporting of roof-to-ground impact conditions in the Malibu test series
- Derived from extensive analysis of dolly rollover tests conducted by GMC in defense of litigation
- Derived and validated from detailed investigation of over 600 rollover accidents in litigation
- Validated by investigation and review of over 400 NASS cases

JRS Impact Conditions

- GM's Malibu studies
  - Conducted by litigation engineers and consultants
  - Two series totaling 16 dolly rollovers
  - Extensively instrumented and filmed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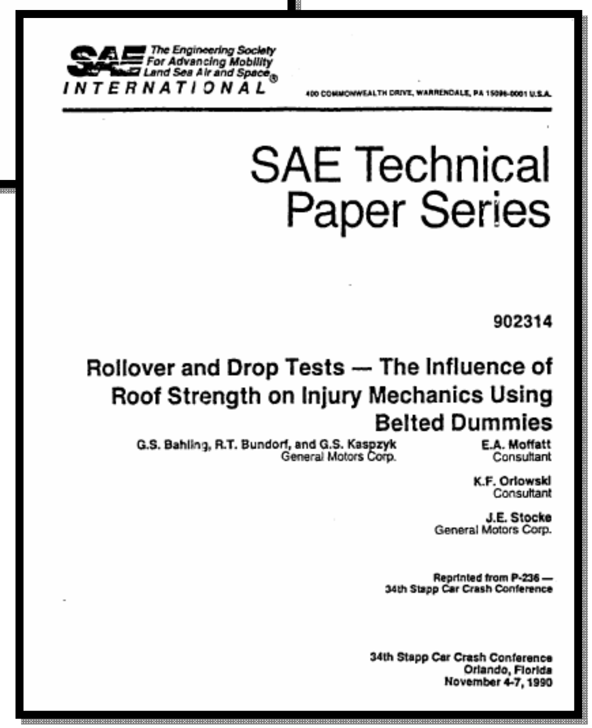
Rollover Crash Tests—The Influence of Roof Strength on Injury Mechanics

Kenneth F. Orlowski and R. Thomas Bundorf
General Motors Corporation
Edward A. Moffatt
Biomech, Inc.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SAE Technical Paper Series

902314

Rollover and Drop Tests — The Influence of Roof Strength on Injury Mechanics Using Belted Dummies

G.S. Bahling, R.T. Bundorf, and G.S. Kaspzyk
General Motors Corp.

E.A. Moffatt
Consultant

K.F. Orlowski
Consultant

J.E. Stocke
General Motors Corp.

Reprinted from P-236 —
34th Stapp Car Crash Conference

34th Stapp Car Crash Conference
Orlando, Florida
November 4-7, 1990

JRS Test Conditions –
Road Bed Speed and Drop Height

- 95% of rollovers are 2 rolls or less
- Typical speed at the initiation of the roll sequence is 20+ mph
- Decrease in rolling velocity due to friction
- CG falls approximately 4” to near side contact

The JRS can run at variable speeds.
We run at 15 or 18 mph on most tests.

JRS Test Conditions – Roll Rate, Angle and Pitch

- In dolly rollover tests, the first near side roll contact occurs at 200º per sec. and 130+ degrees.
- Near side friction increases the roll rate to 300 degrees per sec. by far side impact.
- The pitch can be as little as 5 degrees in low severity rollovers.

JRS Test Conditions – NASS Data

A STUDY OF NASS ROLLOVER CASES AND THE IMPLICATION FOR FEDERAL REGULATION

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Center for Injury Research
Allan Paskin
Xprts, LLC
United States
Paper Number 05-0415

ABSTRACT

NHTSA identified 273 NASS rollover crashes occurring from 1997 through 2000 in which the light vehicles had more than 6 inches of residual roof crush. The agency analyzed these cases, but we have studied them in much more detail. We found a number of important, consistent features that demonstrate conditions that produce rollover injuries, and strongly indicate how rollover casualties can be reduced using readily available technologies. We found: (1) nearly two-thirds were essentially flat ground rollovers without complications; (2) the windshield was always broken when the front of the roof was damaged; (3) virtually all had major damage over an A pillar and a substantial majority had front fender damage indicating that forward pitch in at least one roof impact was roughly 10 degrees; (4) where the vehicle executed more than ½ roll, the initially trailing side of the roof generally had the greatest crush; (5) safety belt use was critical to the pattern of injuries and ejections; (6) the type of roof damage is a function of its design and the nature of the roof impacts; (7) nearly one fifth of the occupants had MAIS 3 or greater injury to the head, face, or cervical spine; and (8) when non-ejected occupants received head, neck or upper torso injuries, they were generally seated on the initially trailing side under a significantly crushed part of the roof. Our study strongly suggests which countermeasures would best address the problem of light vehicle casualties in rollovers, discusses various candidate countermeasures, and estimates the casualty reduction that would result from them. Finally, we discuss the implications for Federal policies.

INTRODUCTION

Several years ago, the National Highway Traffic Safety Administration (NHTSA) asked the public for "views and comments on what changes, if any, are needed to the roof crush resistance standard," Federal motor vehicle safety standard (FMVSS) 216. Shortly afterward, Administrator Jeffrey Runge, M.D. said, "NHTSA plans to propose an upgrade of its roof crush standard to require roofs to allow less crush during a rollover event." As of January 2005, the agency had received 120 comments. Virtually all comments from outside the auto industry support strengthening the standard. The authors of this paper have submitted a large volume of data that should help the agency develop an effective amendment to that and related standards.

NHTSA estimates that 16,000 light vehicle occupants receive serious, non-fatal injuries and that more than 10,000 are killed in rollovers annually. Of those, NHTSA estimated that 28 percent were not ejected and were injured from roof contact (almost all were from roof ...
While NHTSA ...
crush, the Mali...
substantially re...
breakage which ...

The Malibu ...
[4] partial eje...
openings as a re...
ejection was thr...
rollcaged [stro...
breakage than ...
standard vehicle...
were broken, ...
deformation as ...
roll caged vehic...
windows were ...
was broken by ...
dummies in the...
(production) roo...
trailing, or far si...
motor vehicle s...
rollovers – inclu...
is substantial. ...
becoming more ...
light trucks as private passenger vehicles. SUVs, in particular, are grossly overrepresented in producing AIS 3+ injuries in rollovers.

RECENT NHTSA RESEARCH AND ANALYSIS: THE 273 NASS CASES

Last year, NHTSA released two bodies of information that it is using to develop and support an amended FMVSS 216. The first [Pack], is a list of 273 National Accident Sampling System rollover

10º of Pitch in Real World Rollovers

> Damage was observed on the top of at least one front fender in more than 80 percent of the cases for which there were pictures, indicating that the vehicle was pitched at least 10 degrees during at least part of the time it was inverted. This is approximately the angle formed with the horizontal by a line between the top of the roof over the A pillar and the top of the front fender of virtually all contemporary production light vehicles.

Repeatable dynamic tests provide real world consumer information not obtainable with a static test. Data such as, the injury potential performance of:

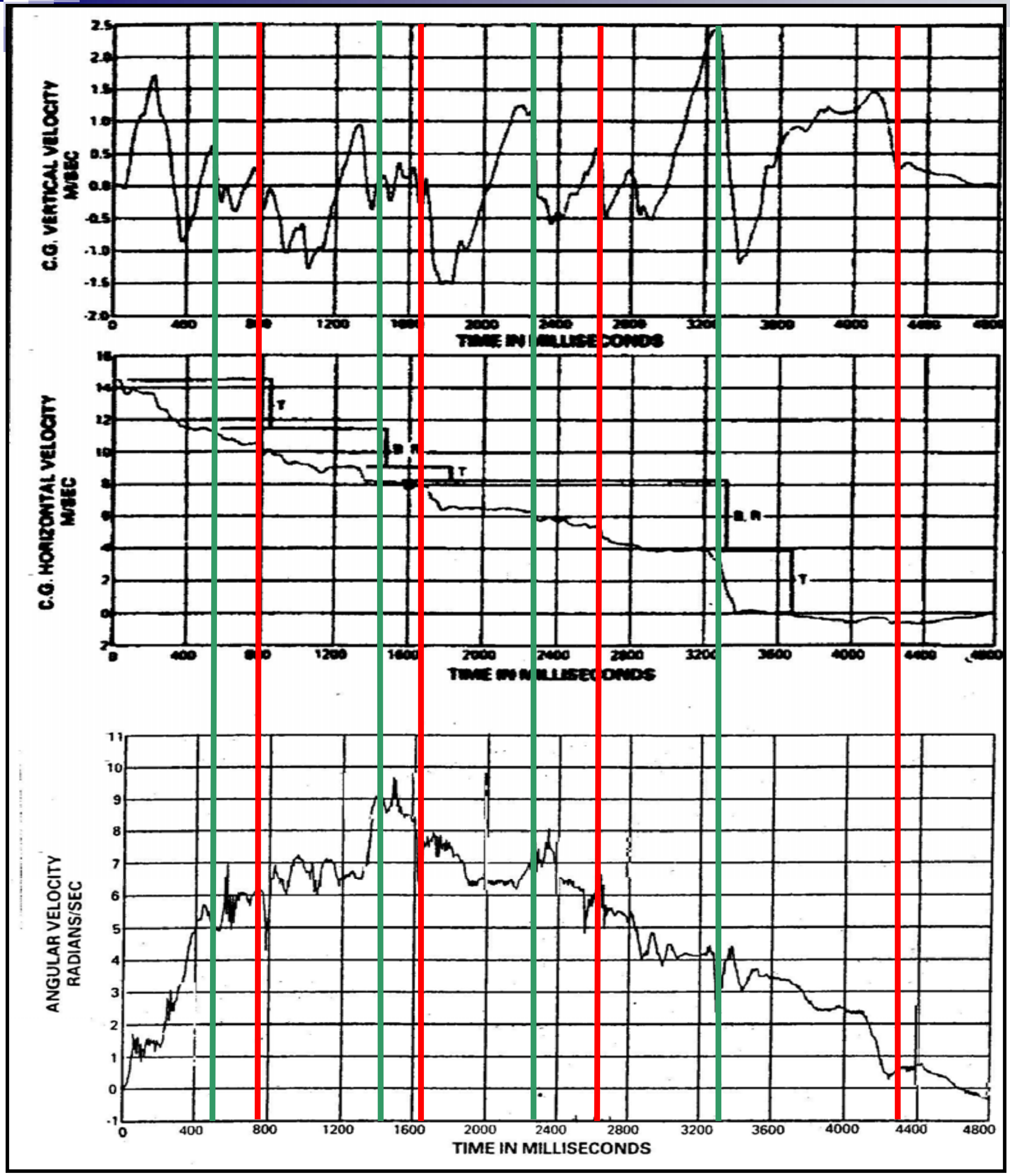
- **child seats,**
- **children and small adults in rear seats,**
- **roof racks,**
- **padding,**
- **belts,**
- **door latches and**

Unregulated and voluntary safety features, like:

- **rollover activated window curtain airbags,**
- **single and dual seat belt pre-tensioners,**
- **tempered and composite glazing and**
- **rollover activated canopy and head impact air bags.**

Furthermore, such testing is consistent with NCAP dynamic tests to injury criteria in the frontal and side impact crash modes.

Technical Details and Results

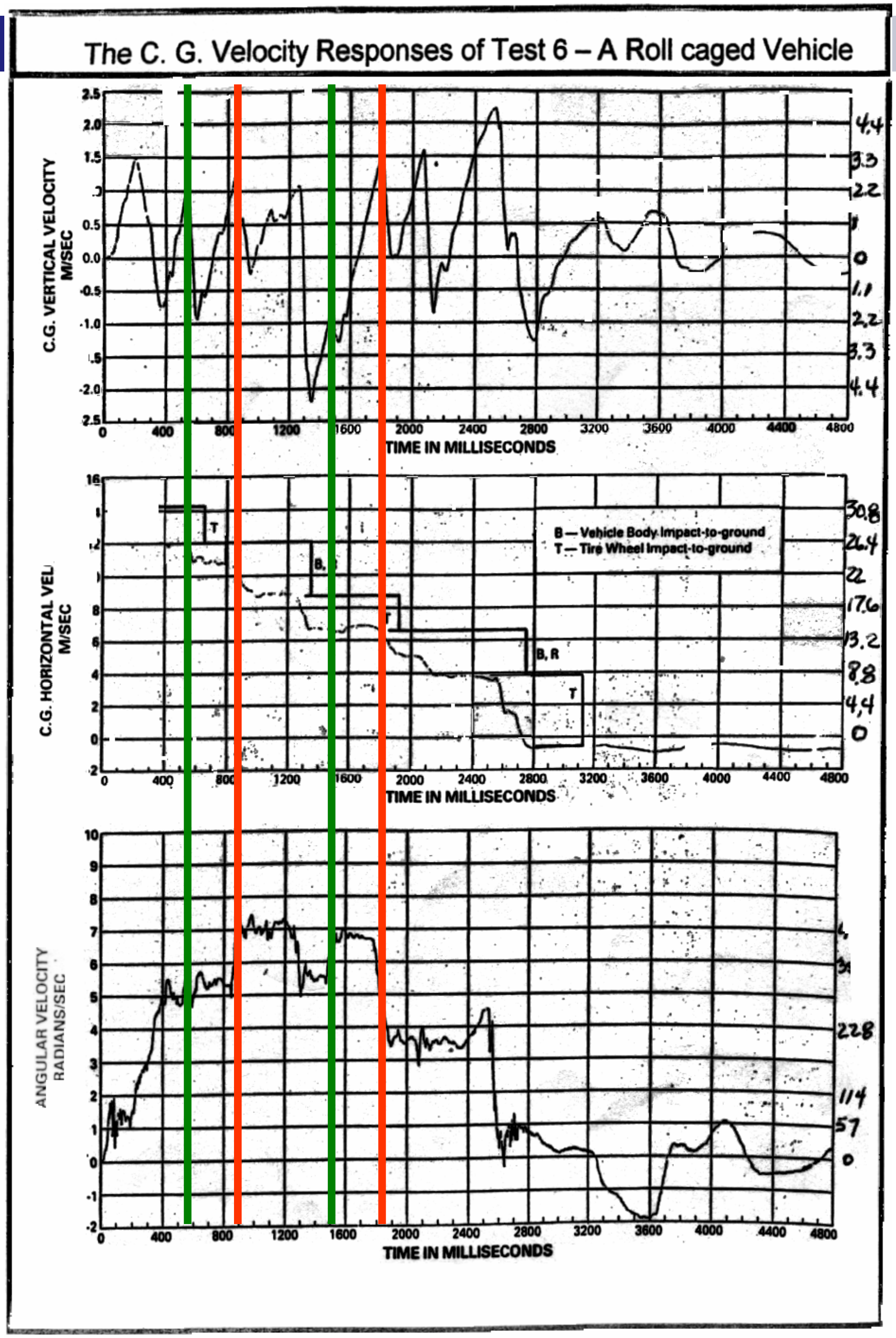


GM Malibu I Test 5

(All data from GM)

Near Side Contacts:
(Green Lines)
550 ms = 0.6 mph
1500 ms = 0.3 mph
2350 ms = 1.2 mph
3350 ms = 1.2 mph

Far Side Contacts:
(Red Lines)
790 ms = 0.6 mph
1677 ms = 0.4 mph
2662 ms = 1.2 mph
4330 ms = 0.7 mph



GM Malibu I Test 6

(All data from GM)

Near Side Contacts: (Green Lines)

575 ms = 2.2 mph

1500 ms = 2.5 mph

Far Side Contacts: (Red Lines)

836 ms = 2.7 mph

1802 ms = 3.1 mph

Note: Similar data between vehicle types. The main difference is the rollcaged vehicle does not crush.

ESV 2001 – Basis for JRS Initial Conditions

PII	Neck Load (N)	Time between Roof Touchdown and Peak Load (ms)	Traveling Speed at Touchdown (mph)	Degrees of Revolution at Neck Load	Vehicle Pitch at Neck Load
3L2	10,900	28	22.1±2.2	210°	5°
3L3	12,000	30	20.0±2.1	1 roll+210°	7°
4L2	7,600	28	21.9±3.2	1 roll+225°	3°
7L4	13,200	5 + 12	6.7±.8	3 rolls+190°	10°

Table 2. Vehicle circumstances at the time of each of the four injurious Malibu II head impacts.

“Advanced Roof Design for Rollover Protection,” Paper No. 01-S12-W-94, 17th International Technical Conference on the Enhanced Safety of Vehicles, June 4-7, 2001

Statistical Probability Analysis of Serious Injury suggests 7 mph Criteria

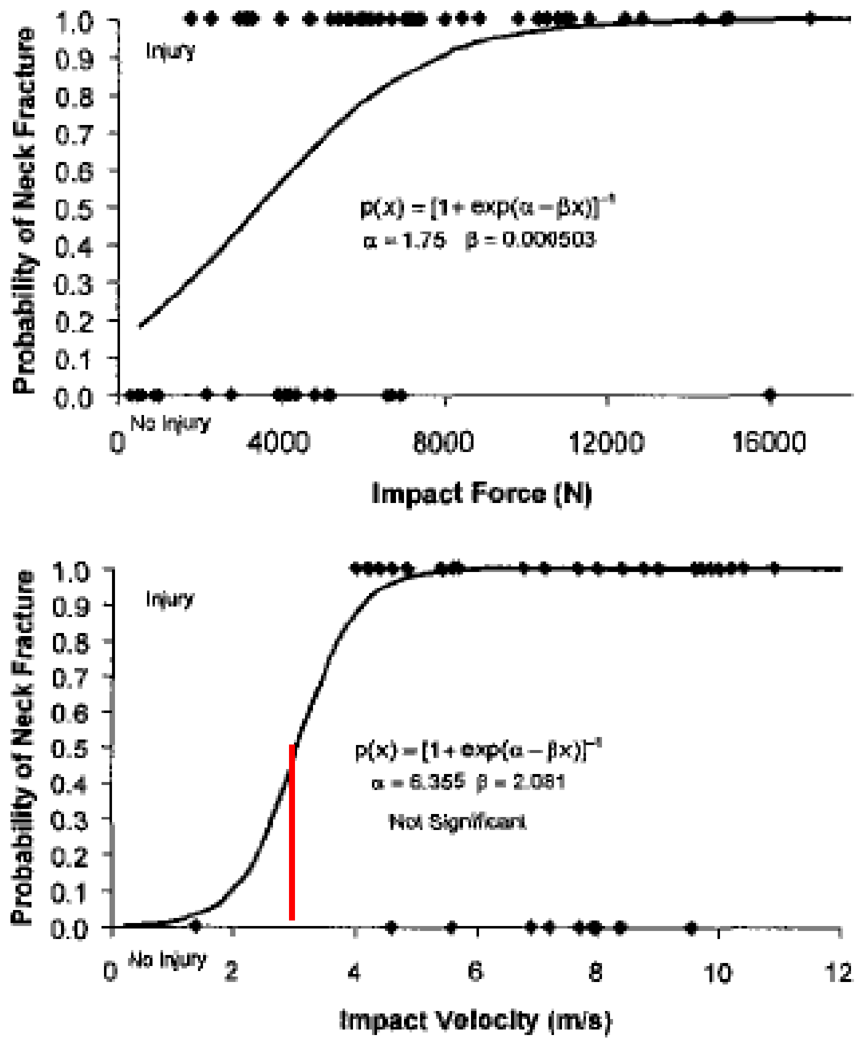


Figure 13: PMHS data on neck fracture versus impact force and impact velocity.

Rollover related Drop tests suggest 10 mph Head impact speed for Severe to Fatal injury

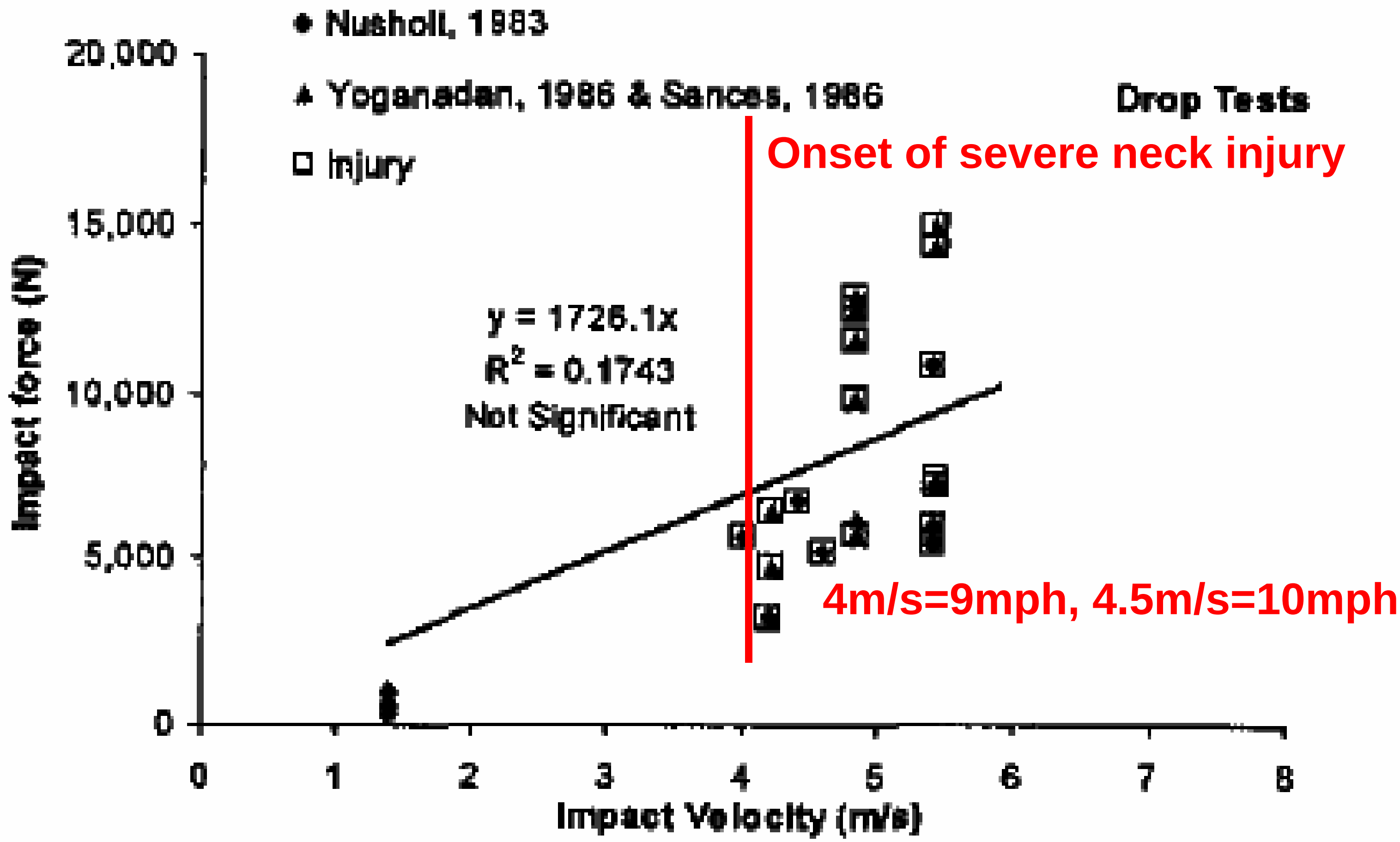
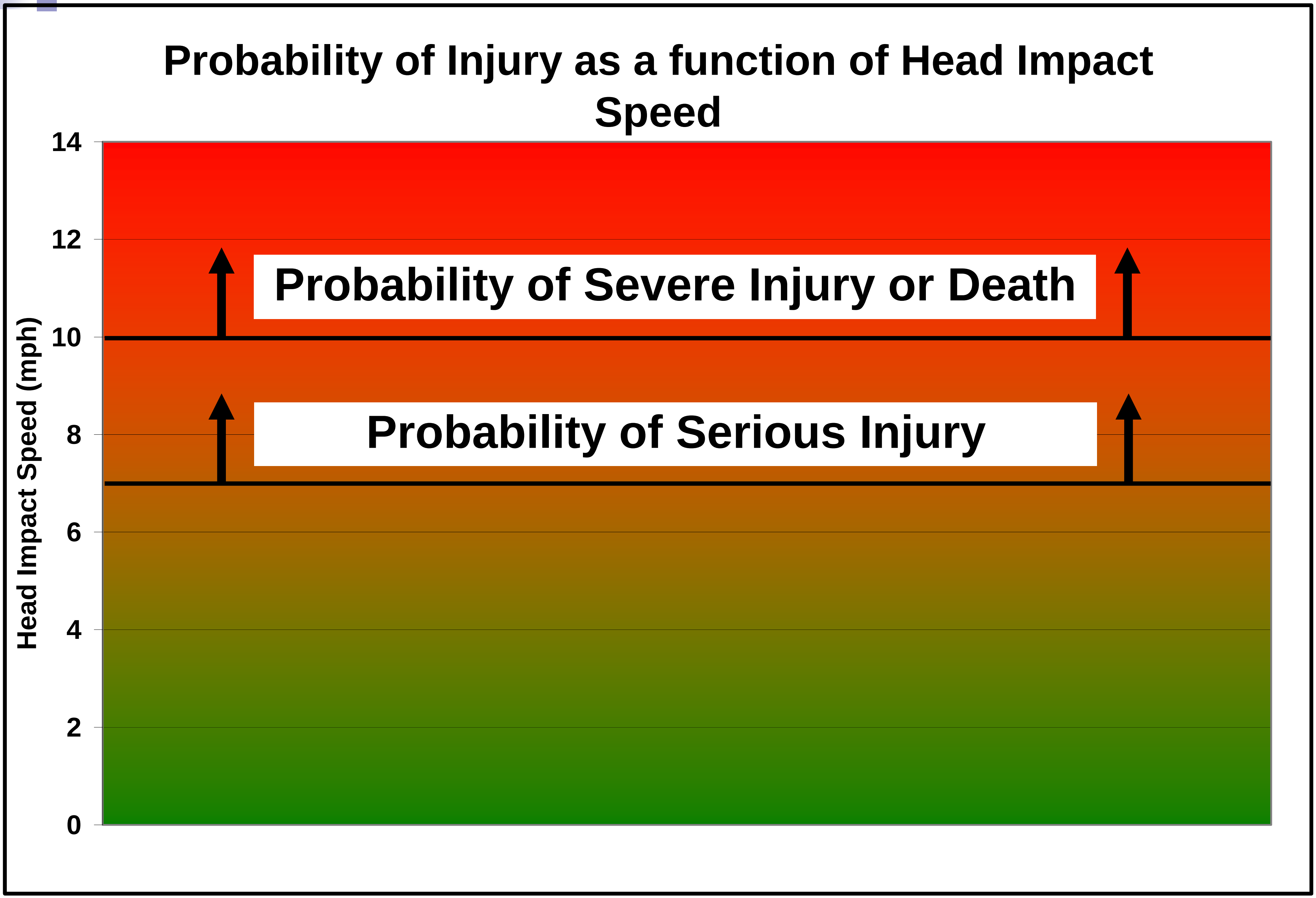


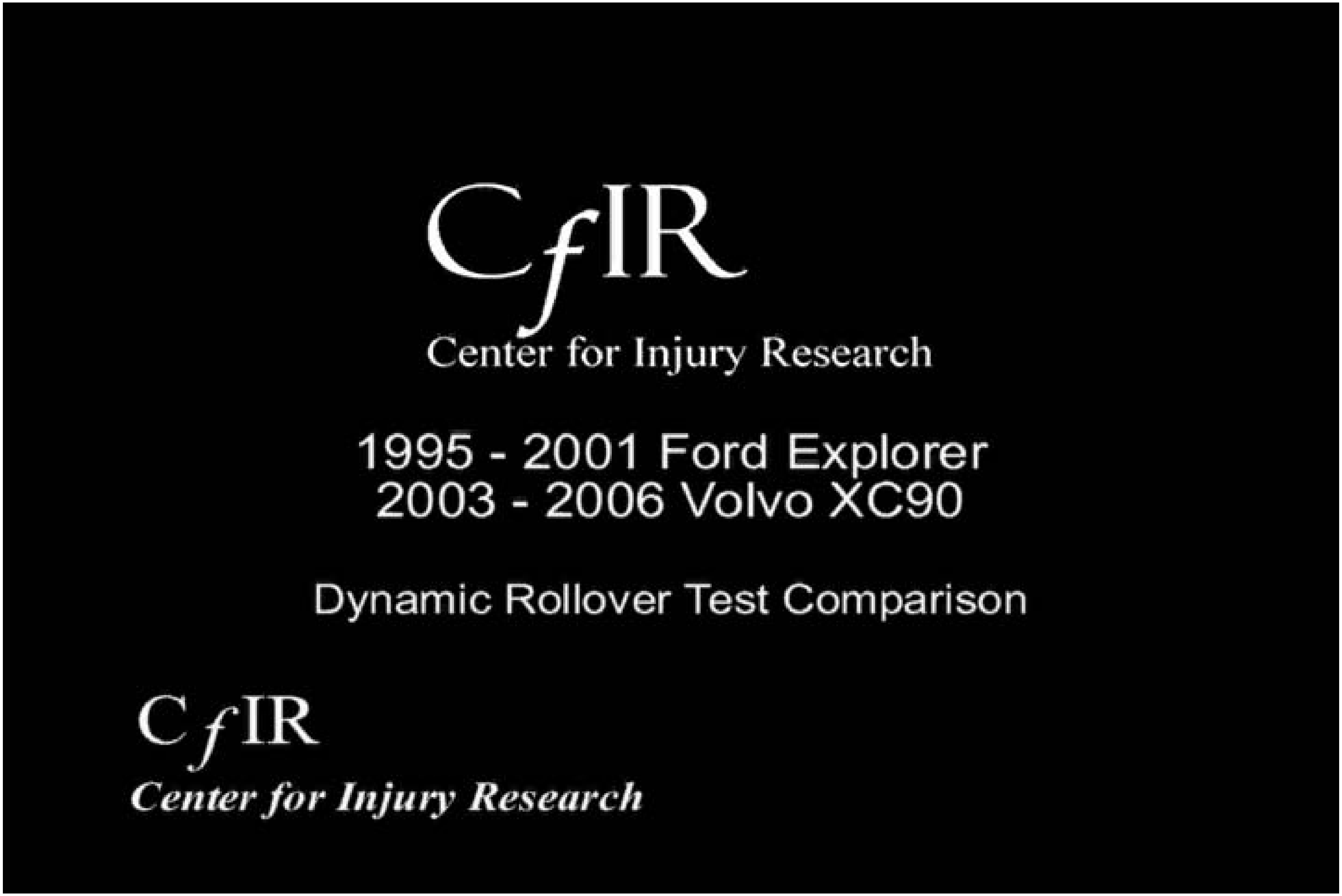
Figure 5: Impact Force as a Function of Impact Velocity for PMHS Drop Tests.


Probability of Injury as a function of Head Impact Speed
Head Impact Speed (mph)
14
12
10
8
6
4
2
0
Probability of Severe Injury or Death
Probability of Serious Injury

Phase II JRS Low Severity Testing

We developed the JRS low severity test protocol to represent rollover crashes at 5° of pitch which are completed in two rolls. This protocol is intended to identify the poorest performing roof designs with high injury and ejection potential

JRS testing is at a roadbed speed of 15 mph, a roll rate of 200°/second, with 5° of pitch, ~140° roll angle, 10° yaw angle and a drop height of 4 inches to the near side.


CfIR
Center for Injury Research
1995 - 2001 Ford Explorer
2003 - 2006 Volvo XC90
Dynamic Rollover Test Comparison
CfIR
Center for Injury Research

2000 Ford Explorer 4dr Roll 1	Crush (in)		Peak Crush Speed
Location	Peak	End of Test	(mph)
A-Pillar	-8.7	-5.9	-6.3
Mid Point Between A and B Pillar	-9.1	-5.9	-6.7
B-Pillar	-6.7	-3.9	-5.5
Inboard of A-Pillar	-7.0	-4.9	-5.8
Inboard of Roof Rail Midpoint	-11.5	-8.5	-12.1
Inboard of B-Pillar	-8.7	-6.2	-9.1
Center of Roof	-8.2	-6.3	-7.6
Near Side A-Pillar	-4.2	-2.0	-3.8

2000 Ford Explorer 2 Roll JRS Test Series

Peak Dynamic Crush – 11.5 inches

Peak Cumulative Crush – 14.5 inches

Peak Crush Speed – 12.1 mph

2000 Ford Explorer 4dr Roll 2	Crush (in)			Peak Crush Speed
Location	Peak	End of Test	Cumulative	(mph)
A-Pillar	-9.2	-6.4	-12.3	-9.6
Mid Point Between A and B Pillar	-9.9	-7.0	-12.9	-9.3
B-Pillar	-9.9	-6.7	-10.6	-8.8
Inboard of A-Pillar	-6.3	-4.2	-9.1	-7.0
Inboard of Roof Rail Midpoint	-9.5	-6.0	-14.5	-9.9
Inboard of B-Pillar	-8.9	-5.6	-11.8	-8.1
Center of Roof	-5.7	-3.1	-9.3	-8.5
Near Side A-Pillar	-2.4	1.0	-1.0	-4.1

2004 Volvo XC90 Roll 1	Crush (in)		Peak Crush Speed
Location	Peak	End of Test	(mph)
A-Pillar	-1.0	-0.1	-1.5
Mid Point Between A and B Pillar	-1.5	-0.3	-2.2
B Pillar	-1.2	-0.1	-1.9
Header Inboard of A-Pillar	-0.6	0.0	-1.2
Front of Sunroof	-1.1	-0.4	-1.8
Side of Sunroof	-1.5	-0.3	-2.3
Near Side A-Pillar	-2.1	-0.9	-3.3
Near Side B-Pillar	-3.2	-1.1	-3.7

2004 Volvo XC90 2 Roll JRS Test Series

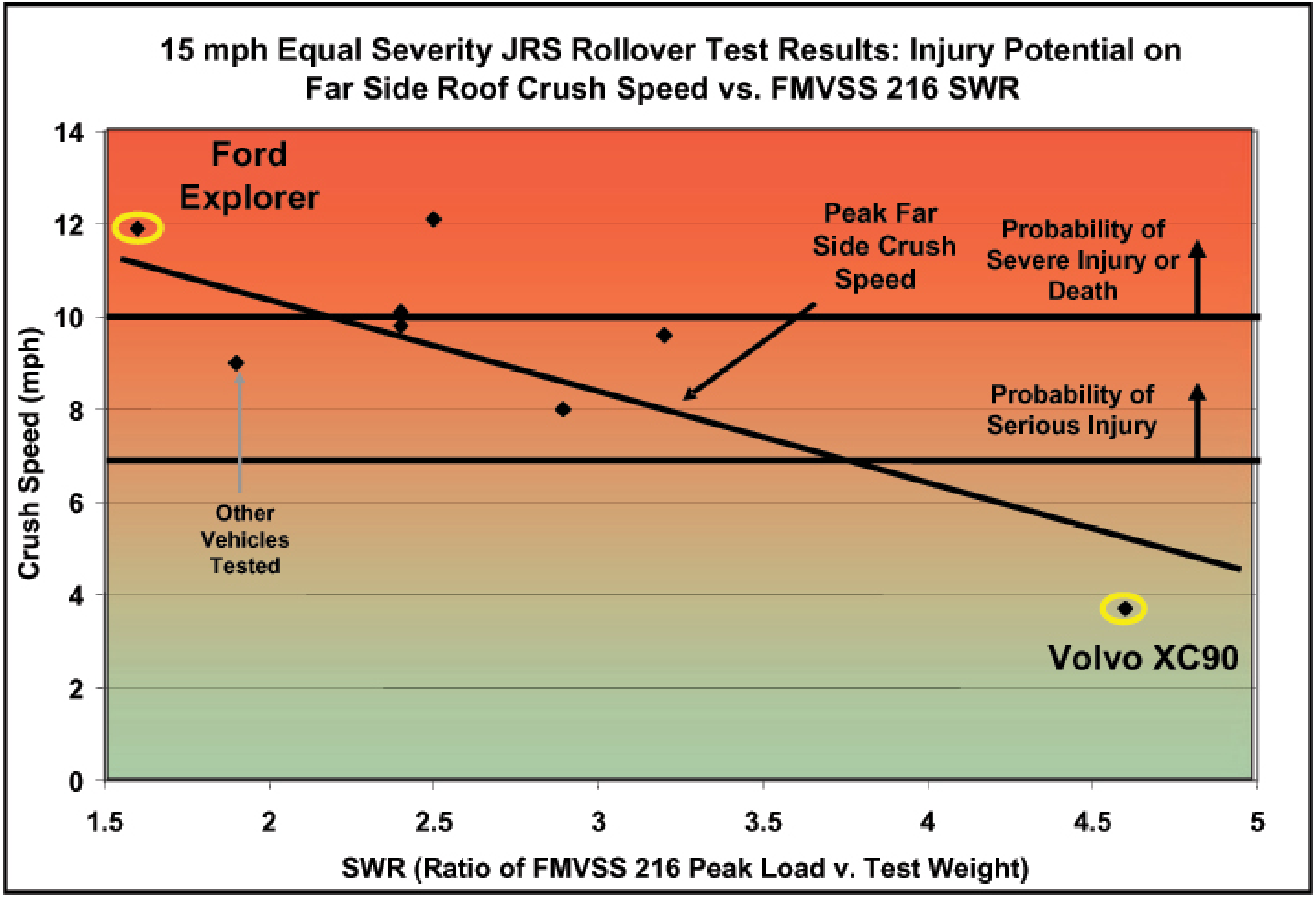
Peak Dynamic Crush* – 2.6 inches

Peak Cumulative Crush* – 1.1 inches

Peak Crush Speed* – 3.0 mph

* Far side only

2004 Volvo XC90 Roll 2	Crush (in)			Peak Crush Speed
Location	Peak	End of Test	Cumulative	(mph)
A-Pillar	-1.9	-0.5	-0.6	-2.0
Mid Point Between A and B Pillar	-2.6	-0.7	-1.0	-2.9
B Pillar	-2.6	-0.7	-0.9	-3.0
Header Inboard of A-Pillar	-1.2	-0.3	-0.3	-1.4
Front of Sunroof	-1.6	-0.5	-0.8	-2.1
Side of Sunroof	-2.5	-0.7	-1.1	-2.9
Near Side A-Pillar	-0.3	0.2	-0.7	-1.1
Near Side B-Pillar	-0.9	0.3	-0.8	-1.8


15 mph Equal Severity JRS Rollover Test Results: Injury Potential on Far Side Roof Crush Speed vs. FMVSS 216 SWR
Ford Explorer
Peak Far Side Crush Speed
Probability of Severe Injury or Death
Probability of Serious Injury
Other Vehicles Tested
Volvo XC90
Crush Speed (mph)
14
12
10
8
6
4
2
0
1.5
2
2.5
3
3.5
4
4.5
5
SWR (Ratio of FMVSS 216 Peak Load v. Test Weight)

JRS 15 mph Low Severity Dynamic Rolls Ordered by Max. Roof Crush Speed at any Point for Injury Potential Evaluation

Model Years	Make/Models	216 SWR	Max Crush (Inches)	Maximum Speed (MPH)	Injury Probability
2002-2006	Volvo XC90 SUV	4.6	3.2	3.7	Best
1999-2005	Hyundai Sonata Sedan	2.8	6.4	8.0	Fair
2003-2006	Kia Sorrento SUV	1.9	6.9	9.0	Poor
1995-1999	Nissan Sentra Sedan	3.2	9.1	9.6	Poor
1995-2001	GMC Jimmy SUV	2.4	6.7	9.8	Poor
1995-2005	Chevy Blazer SUV	2.4	9.6	10.1	Not Acceptable
1999-2001	Isuzu VehiCross SUV	NA	6.8	11.1	Not Acceptable
2001-2006	C2500 HD Reg Cab Pickup	2.2	9.9	11.2	Not Acceptable
1995-2001	Ford Explorer SUV	1.6	11.5	12.1	Not Acceptable
1994-1999	Mitsubishi Eclipse	2.5	7.6	12.1	Not Acceptable

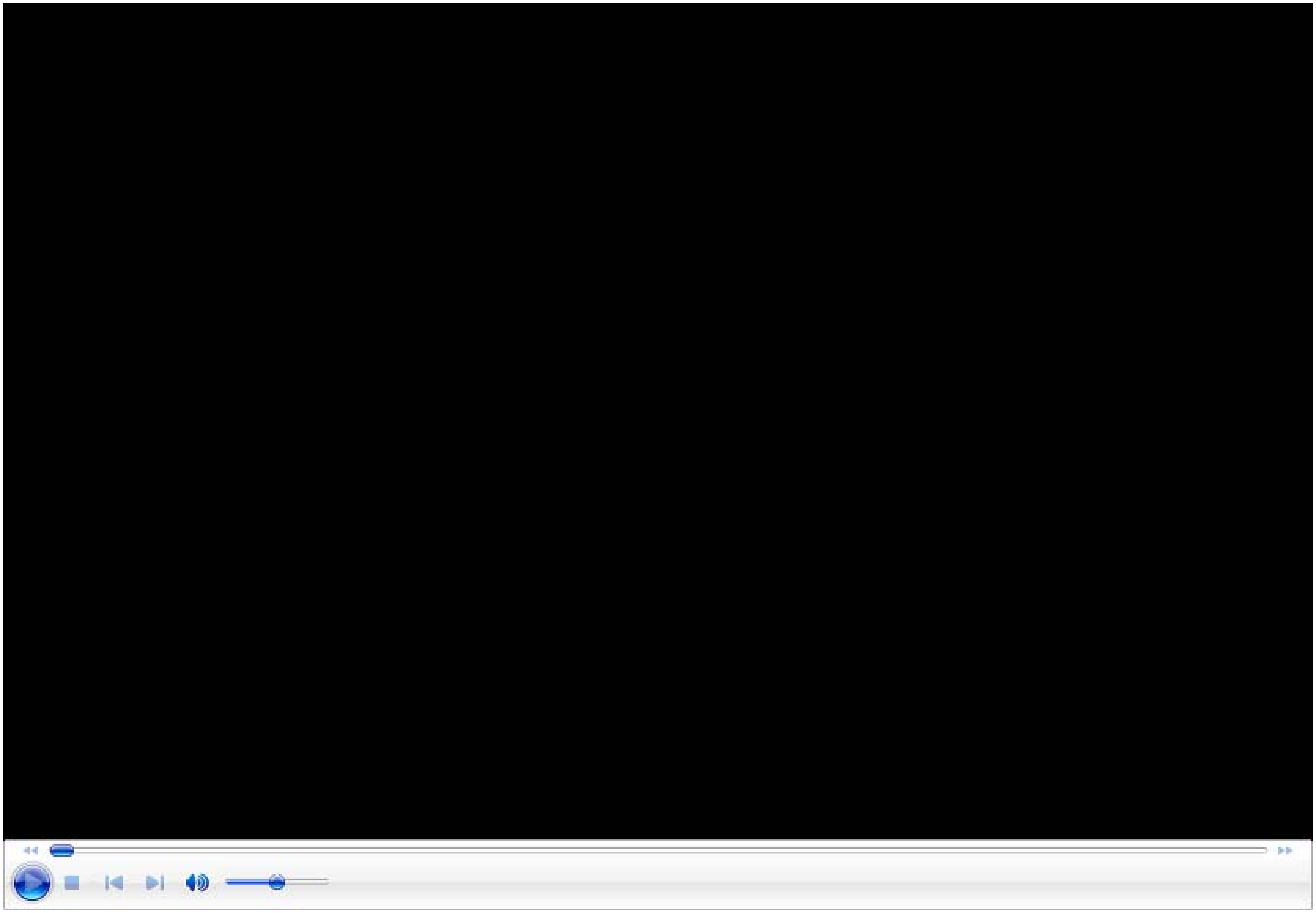
(Criteria: Best = < 6mph and no ejection portals; Good = < 6 mph; Fair = < 8 mph; Poor = < 10 mph; Not Acceptable = > 10mph)

JRS Real World Severity Testing

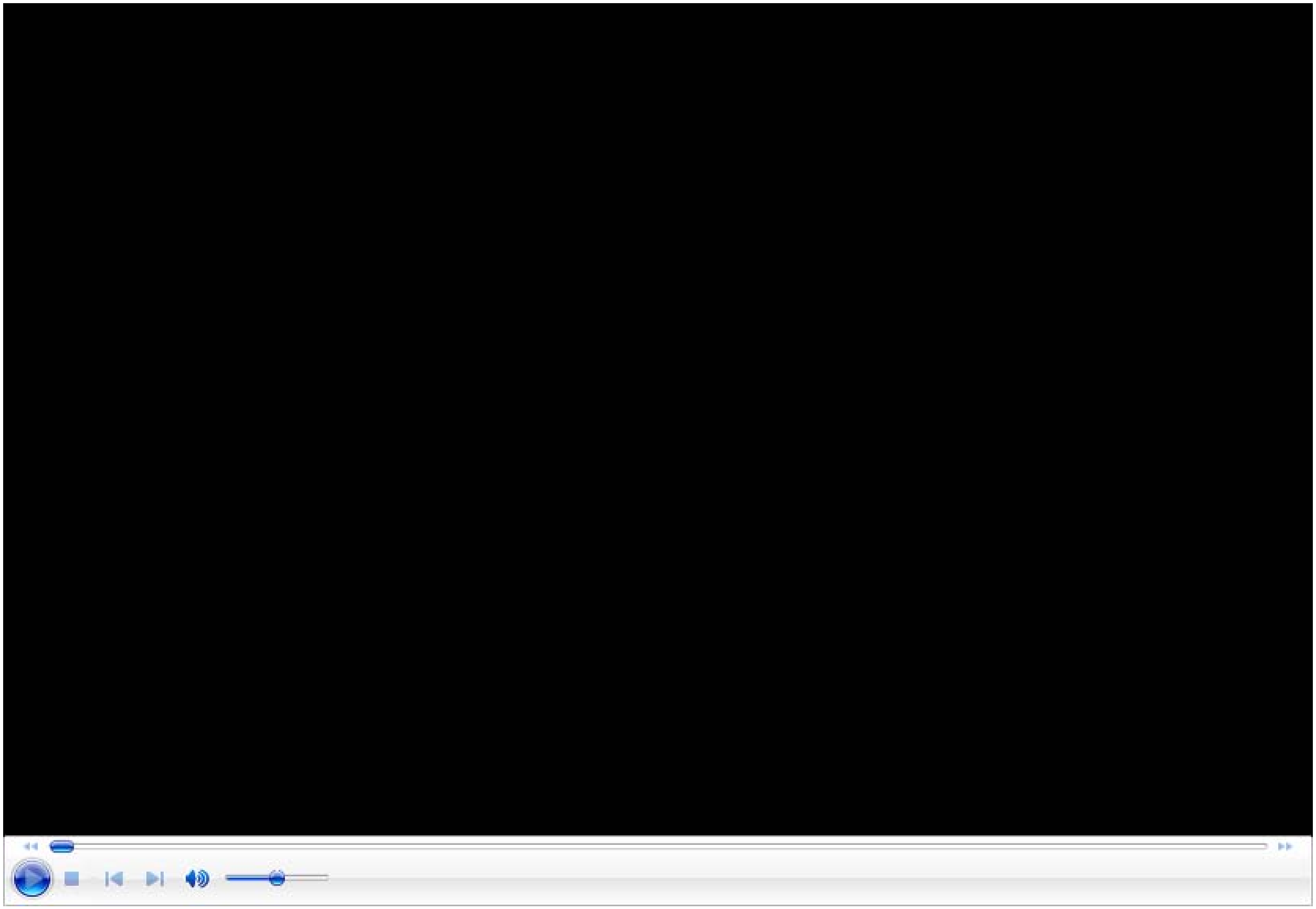
We developed the Phase III JRS real world test protocol to represent 95% of the rollovers, which are in two rolls, where 95% of the serious to fatal injuries occur.

Real world JRS testing is at a roadbed speed of 18 mph, a roll rate of 240°/second, with 10° of pitch, 145° roll angle, 10° yaw angle and a drop height of 4 inches to the near side.

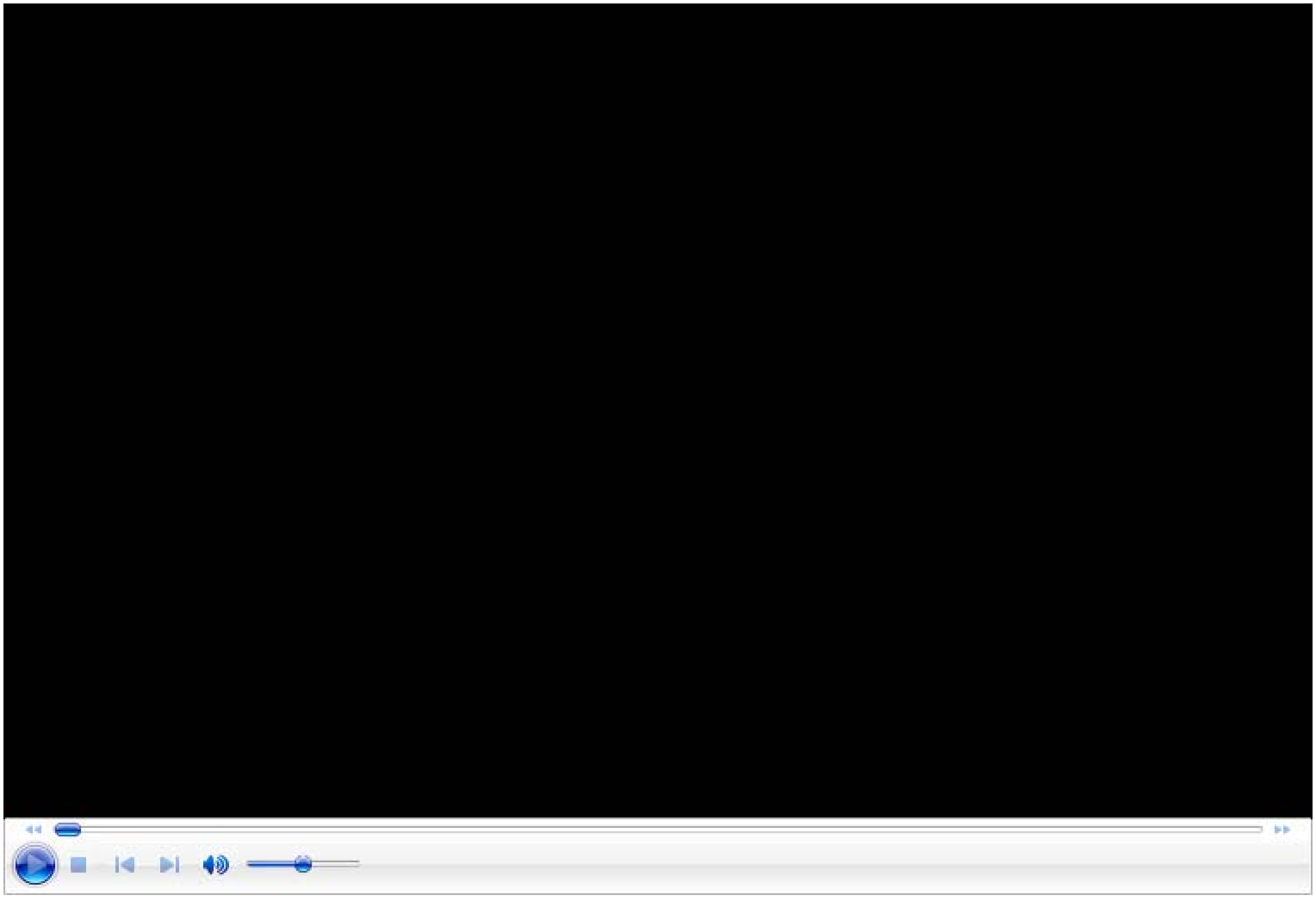
JRS 1998 Reinforced Blazer Tests



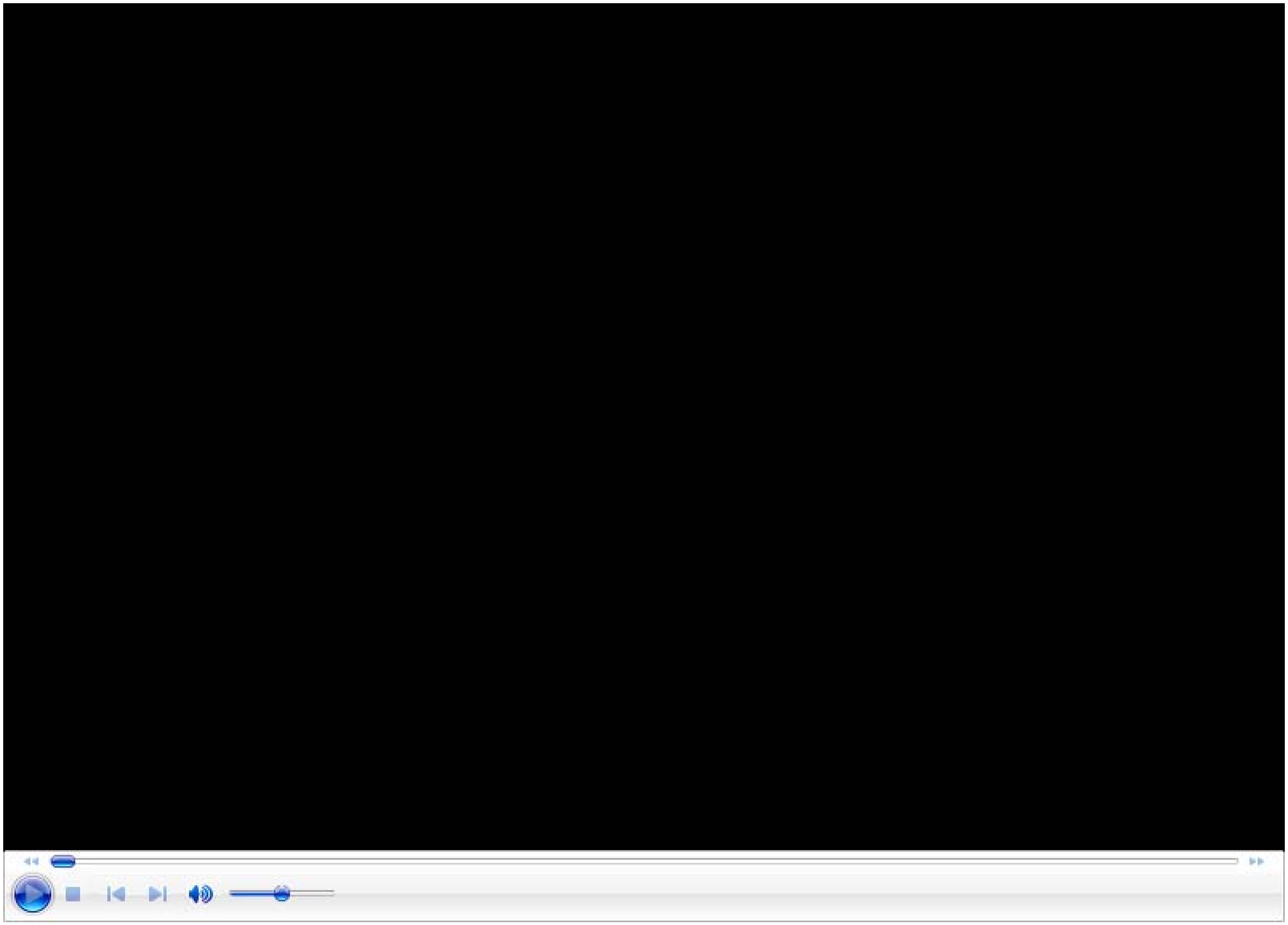
JRS 1993 Cherokee Tests



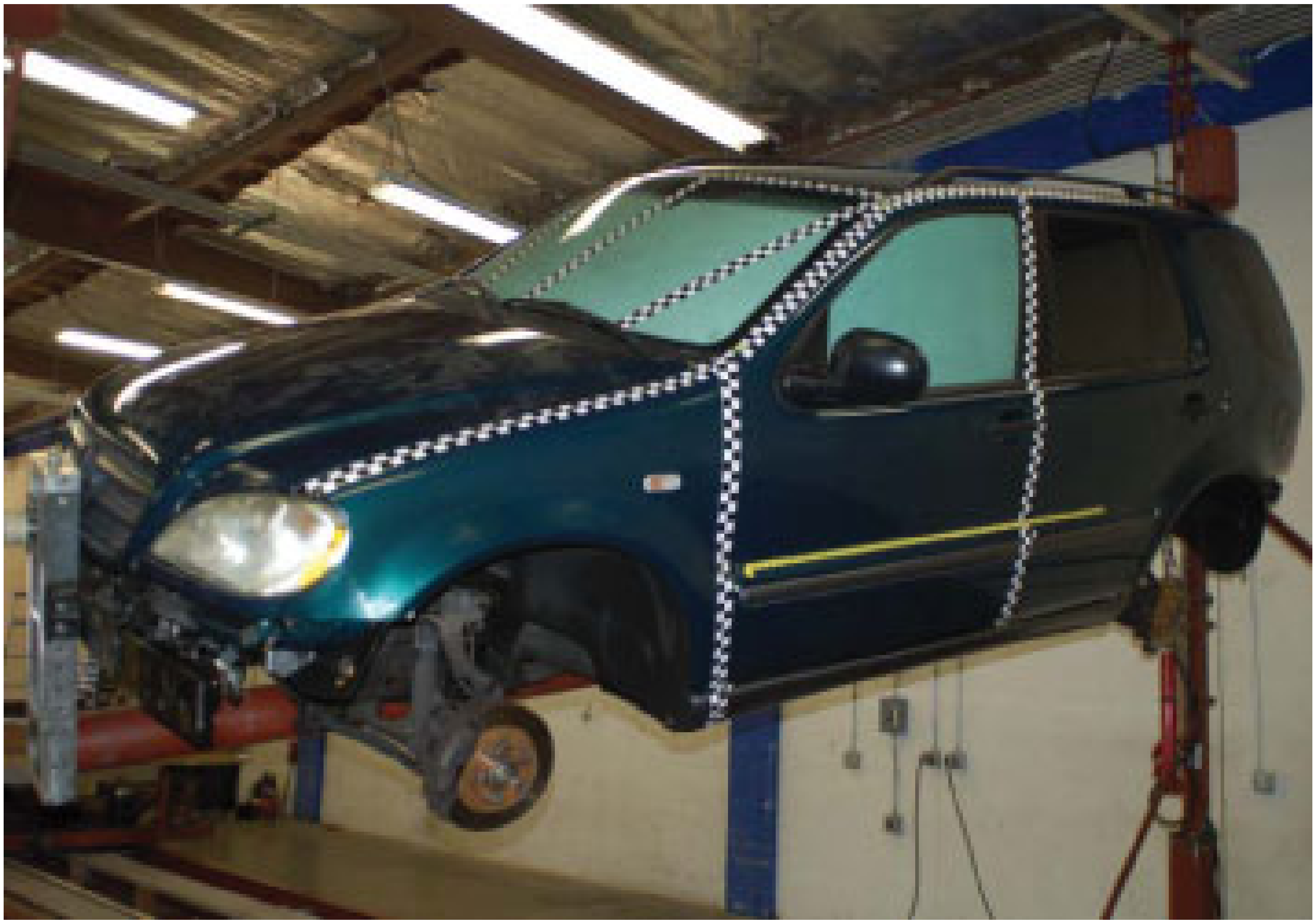
JRS 1996 Isuzu Rodeo Test



JRS 2001 Suburban Test

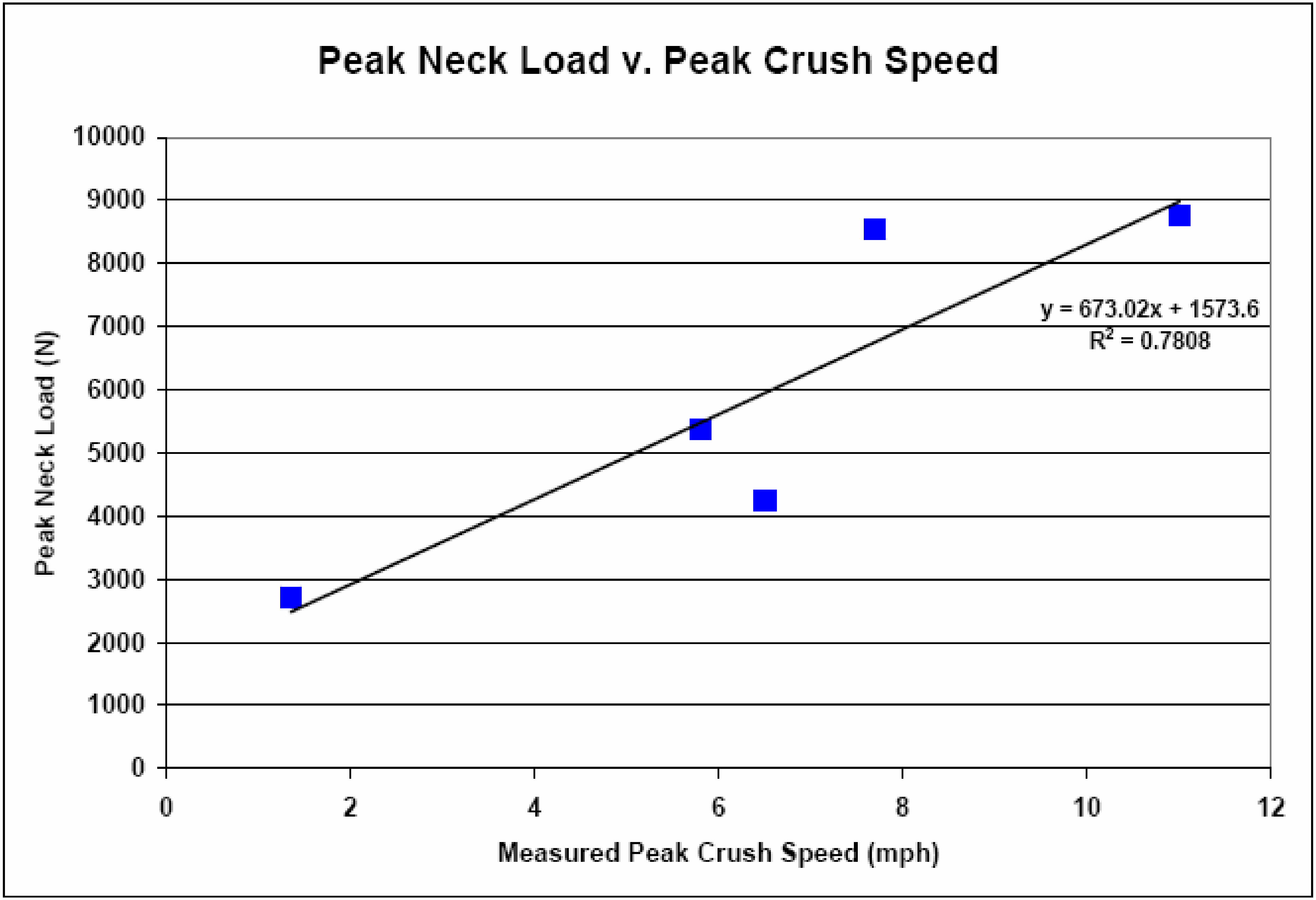


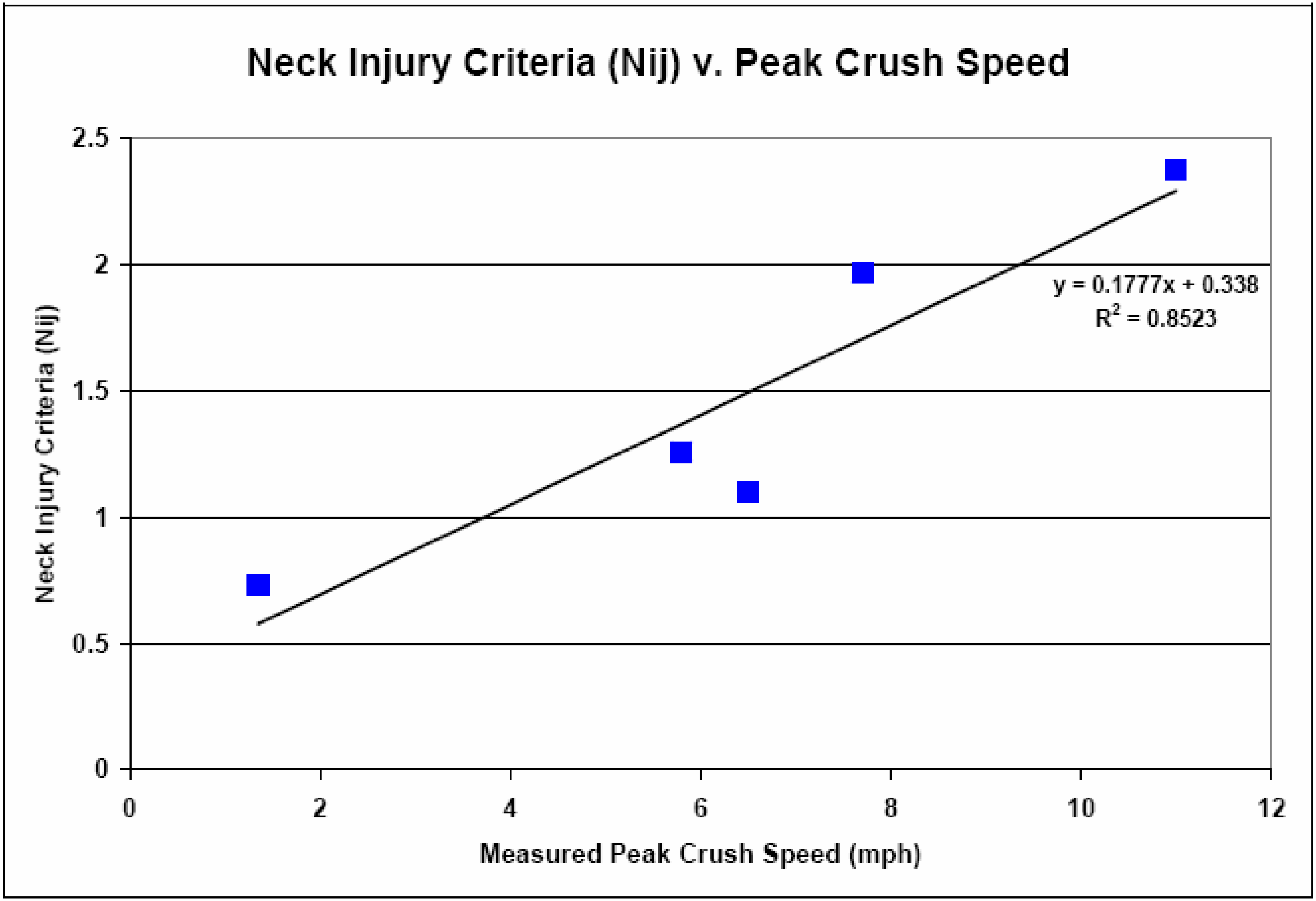
JRS 1998 Mercedes ML320 Test



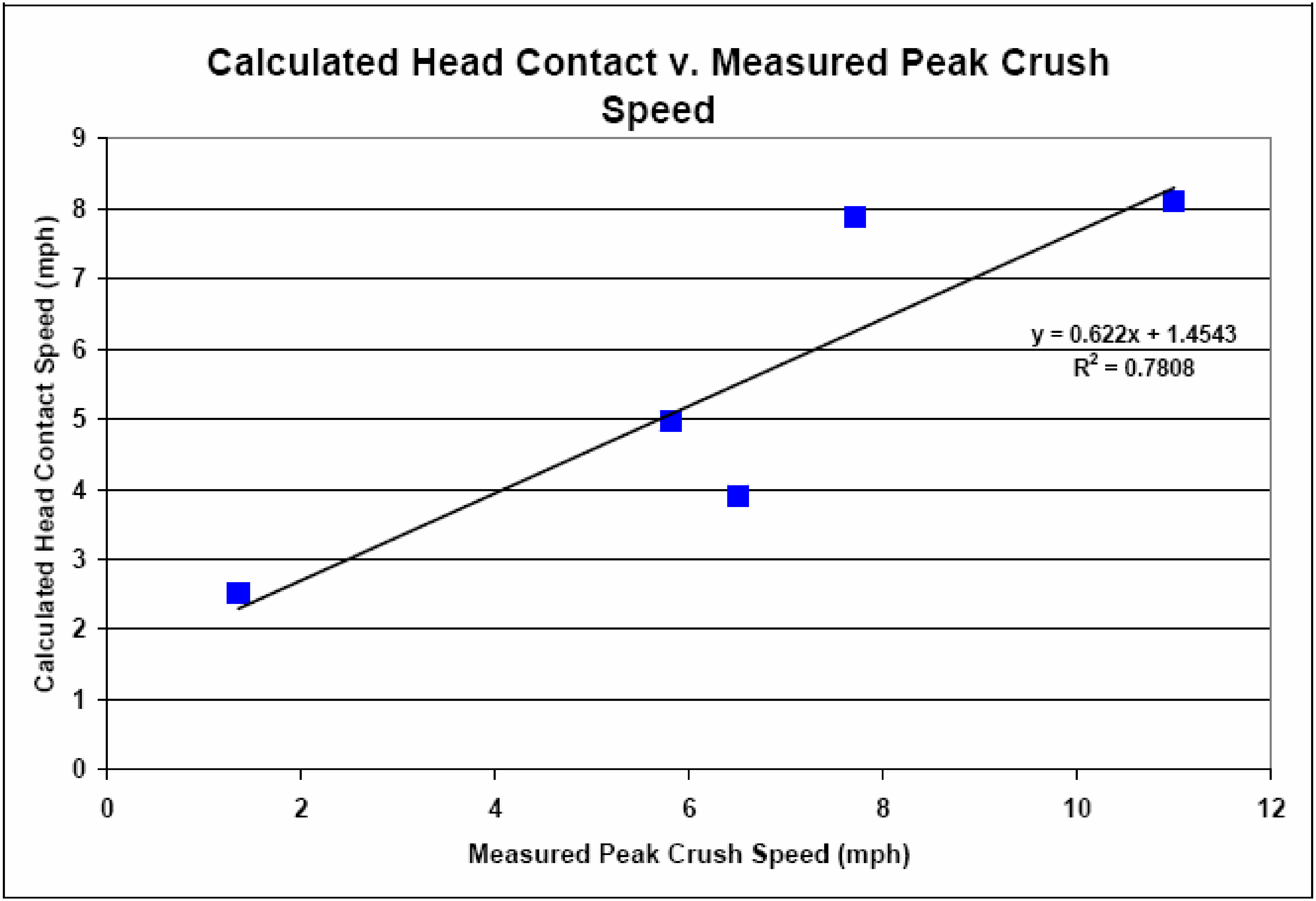
JRS 1999 Jeep Grand Cherokee

JRS 18 mph, 10º Pitch, 1998 ML320 Test

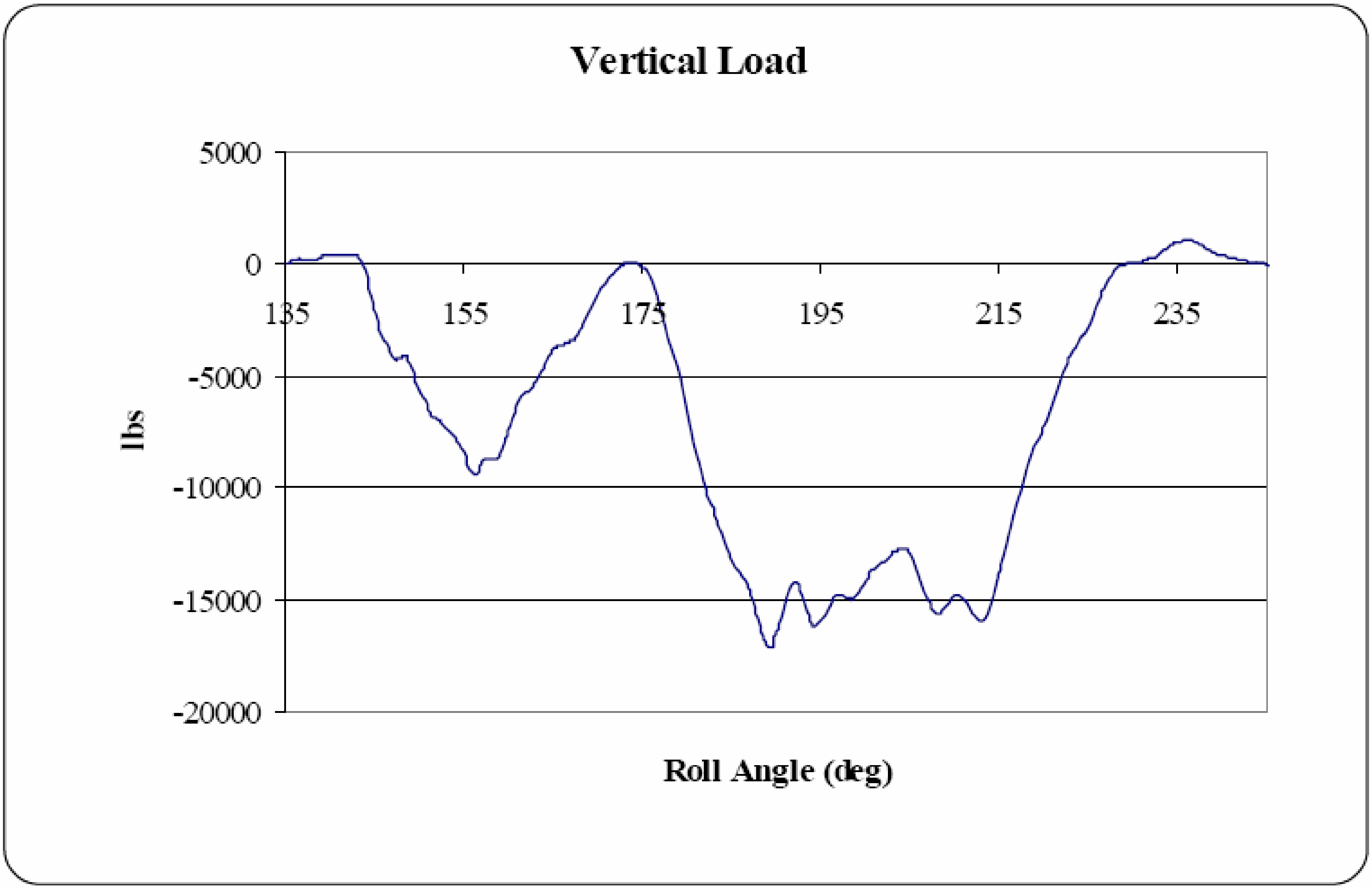

Peak Neck Load v. Peak Crush Speed
y = 673.02x + 1573.6
R^2 = 0.7808
Peak Neck Load (N)
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
0
2
4
6
8
10
12
Measured Peak Crush Speed (mph)



Neck Injury Criteria (Nij) v. Peak Crush Speed
y = 0.1777x + 0.338
R2 = 0.8523
Neck Injury Criteria (Nij)
2.5
2
1.5
1
0.5
0
0
2
4
6
8
10
12
Measured Peak Crush Speed (mph)

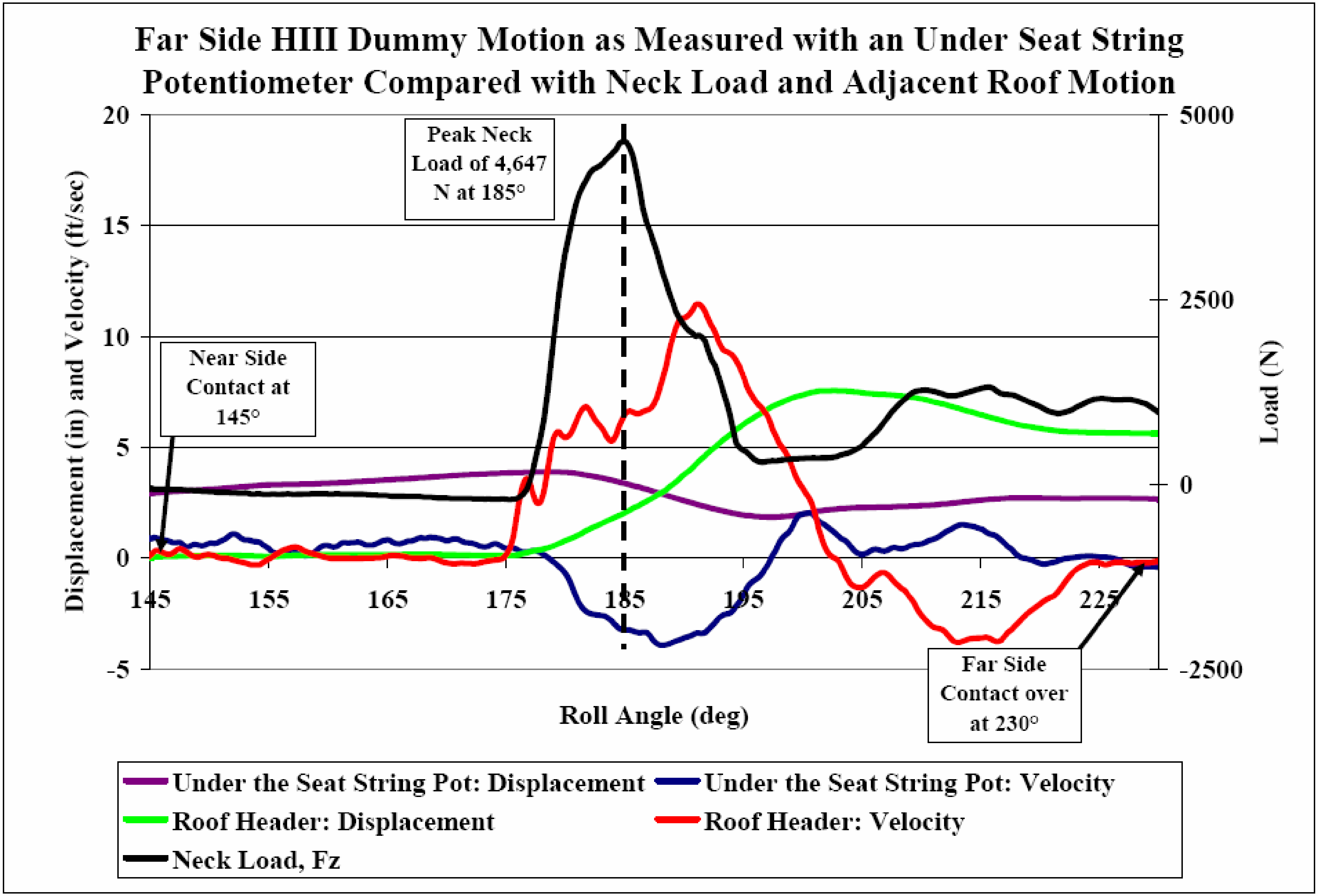

Calculated Head Contact v. Measured Peak Crush Speed
y = 0.622x + 1.4543
R2 = 0.7808
Calculated Head Contact Speed (mph)
Measured Peak Crush Speed (mph)
0
1
2
3
4
5
6
7
8
9
0
2
4
6
8
10
12

Load as Measured on the Road Bed

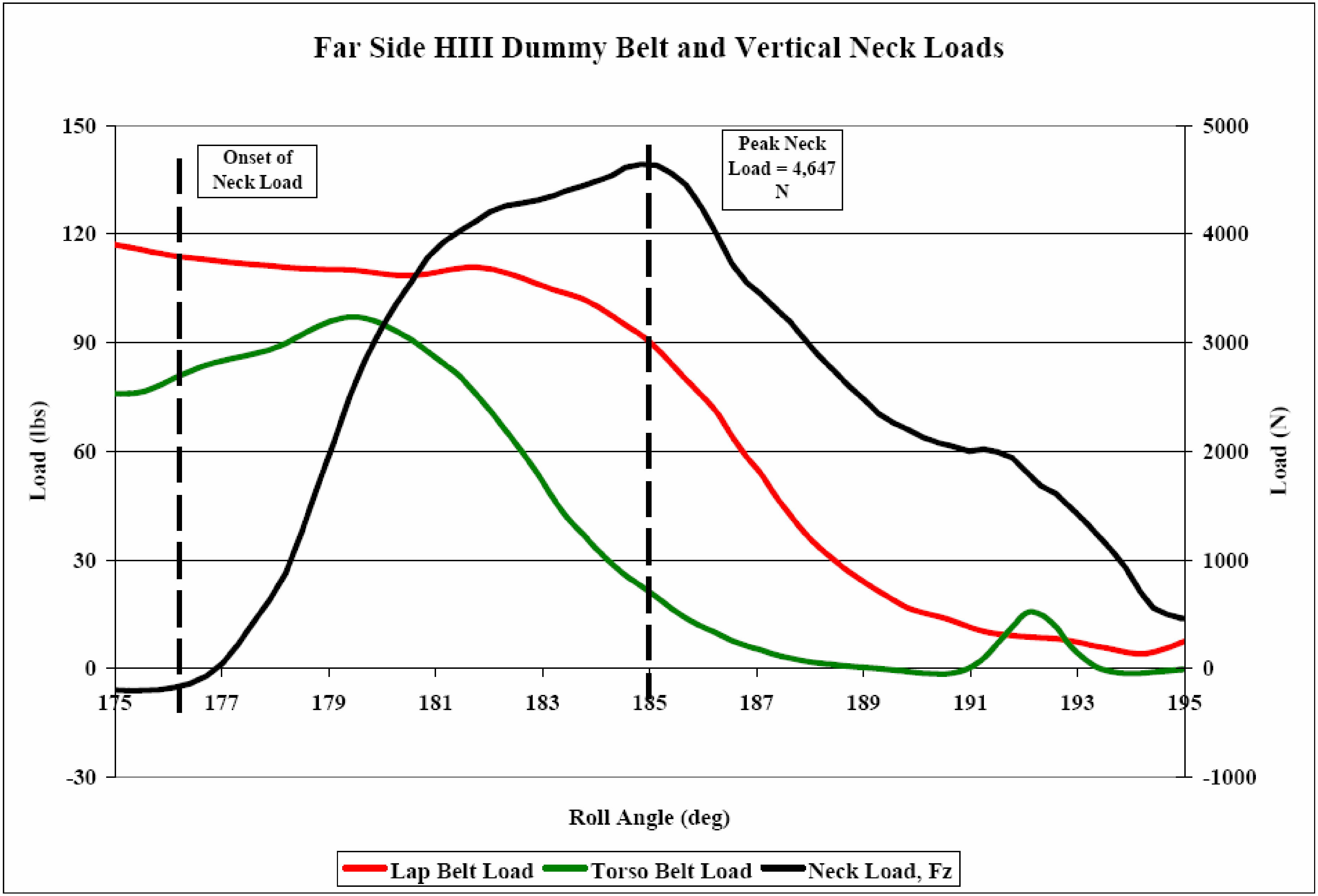


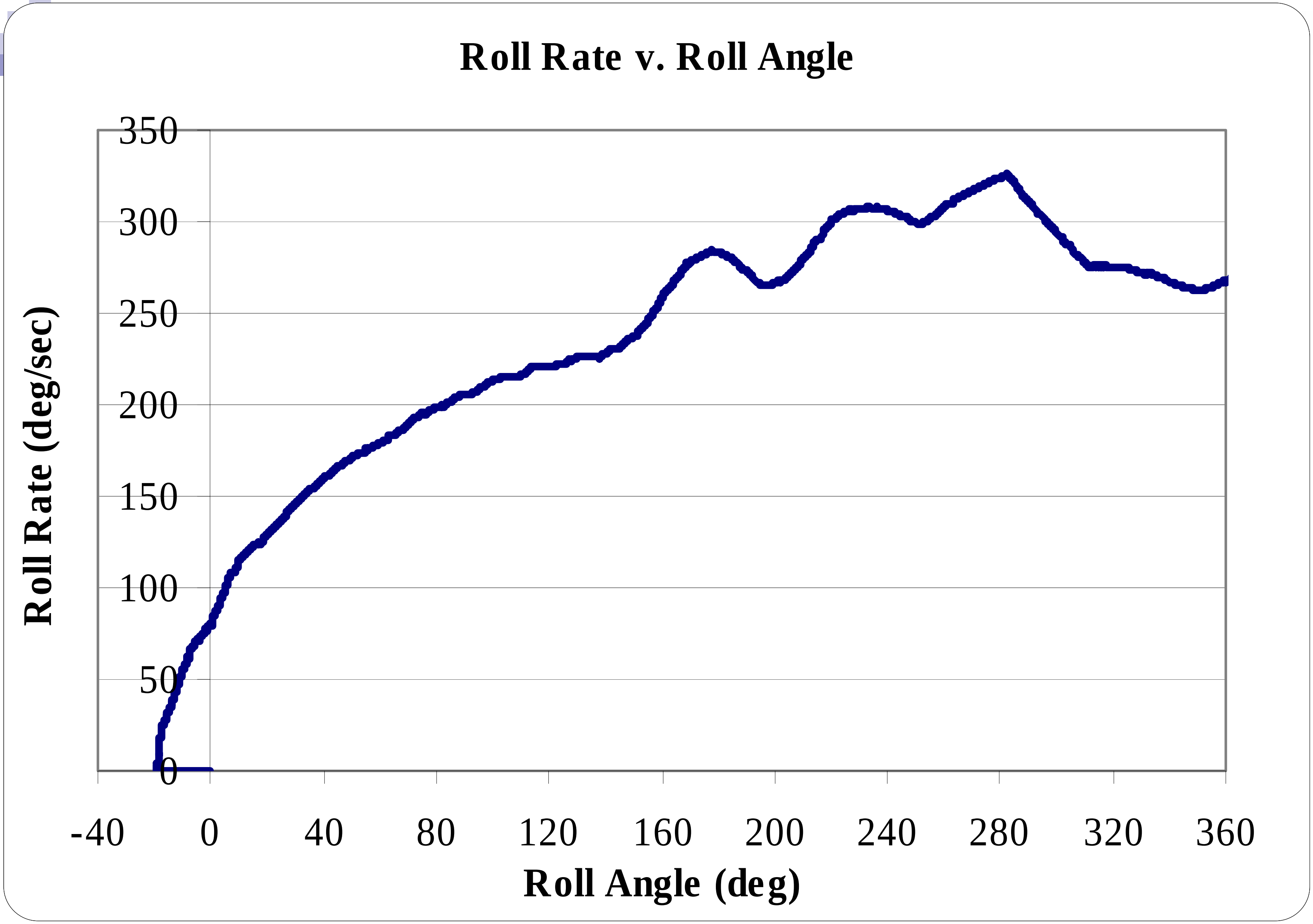
Measured Intrusion and Speed Adjacent to Dummy

1998 Mercedes ML	Intrusion (in)		Peak Intrusion Velocity	
Location	Peak	End of Test	(ft/sec)	(mph)
A-Pillar	-7.7	-5.3	-11.2	-7.6
B-Pillar	-5.4	-2.8	-7.9	-5.4
Roof Header	-7.6	-5.4	-11.5	-7.8
Near Side A-Pillar	-0.9	0.6	-3.0	-2.0

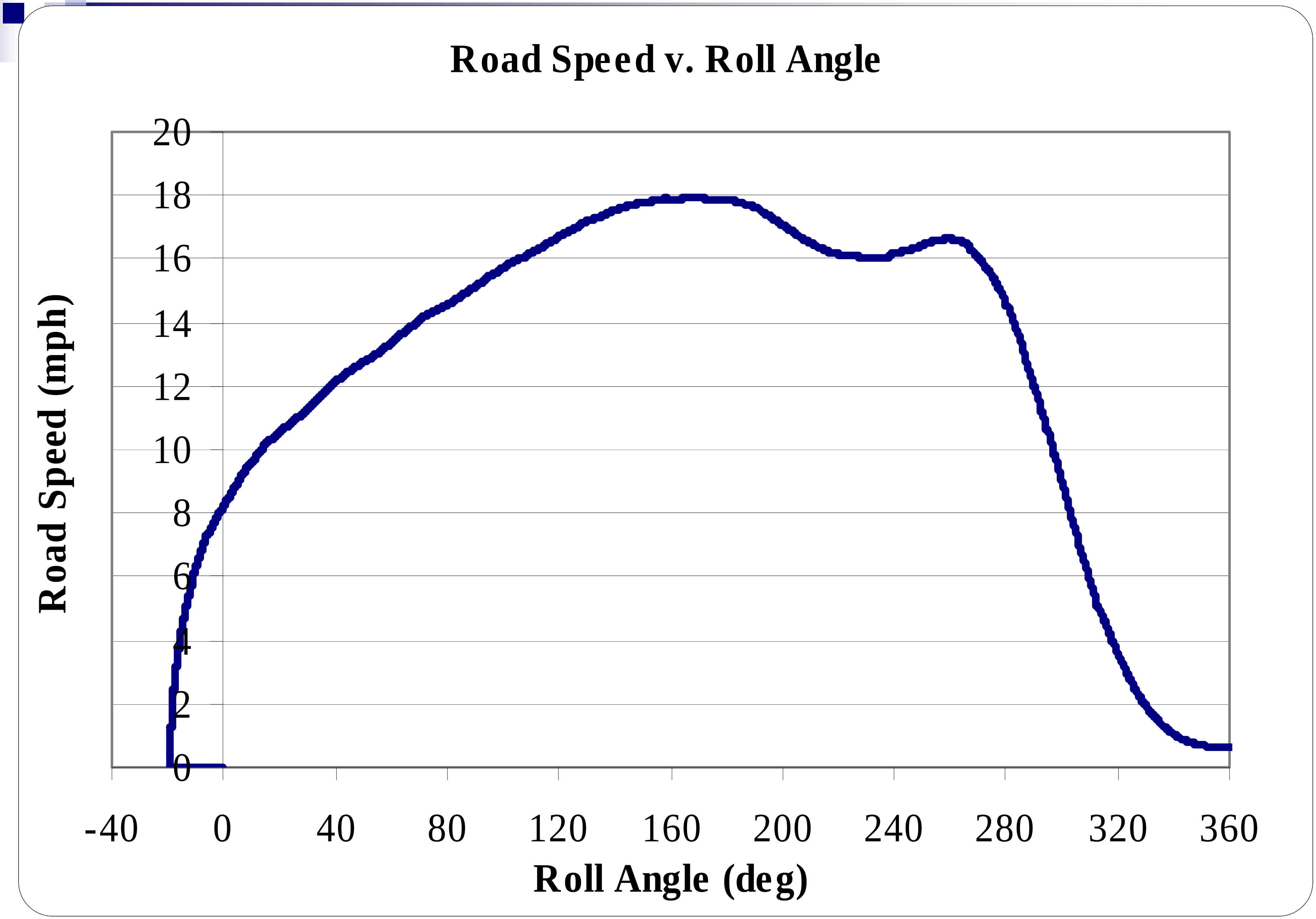


Far Side HIII Dummy Motion as Measured with an Under Seat String Potentiometer Compared with Neck Load and Adjacent Roof Motion
Peak Neck Load of 4,647 N at 185°
Near Side Contact at 145°
Far Side Contact over at 230°
Displacement (in) and Velocity (ft/sec)
Load (N)
Roll Angle (deg)
20
15
10
5
0
-5
5000
2500
0
-2500
145
155
165
175
185
195
205
215
225
Under the Seat String Pot: Displacement
Under the Seat String Pot: Velocity
Roof Header: Displacement
Roof Header: Velocity
Neck Load, Fz

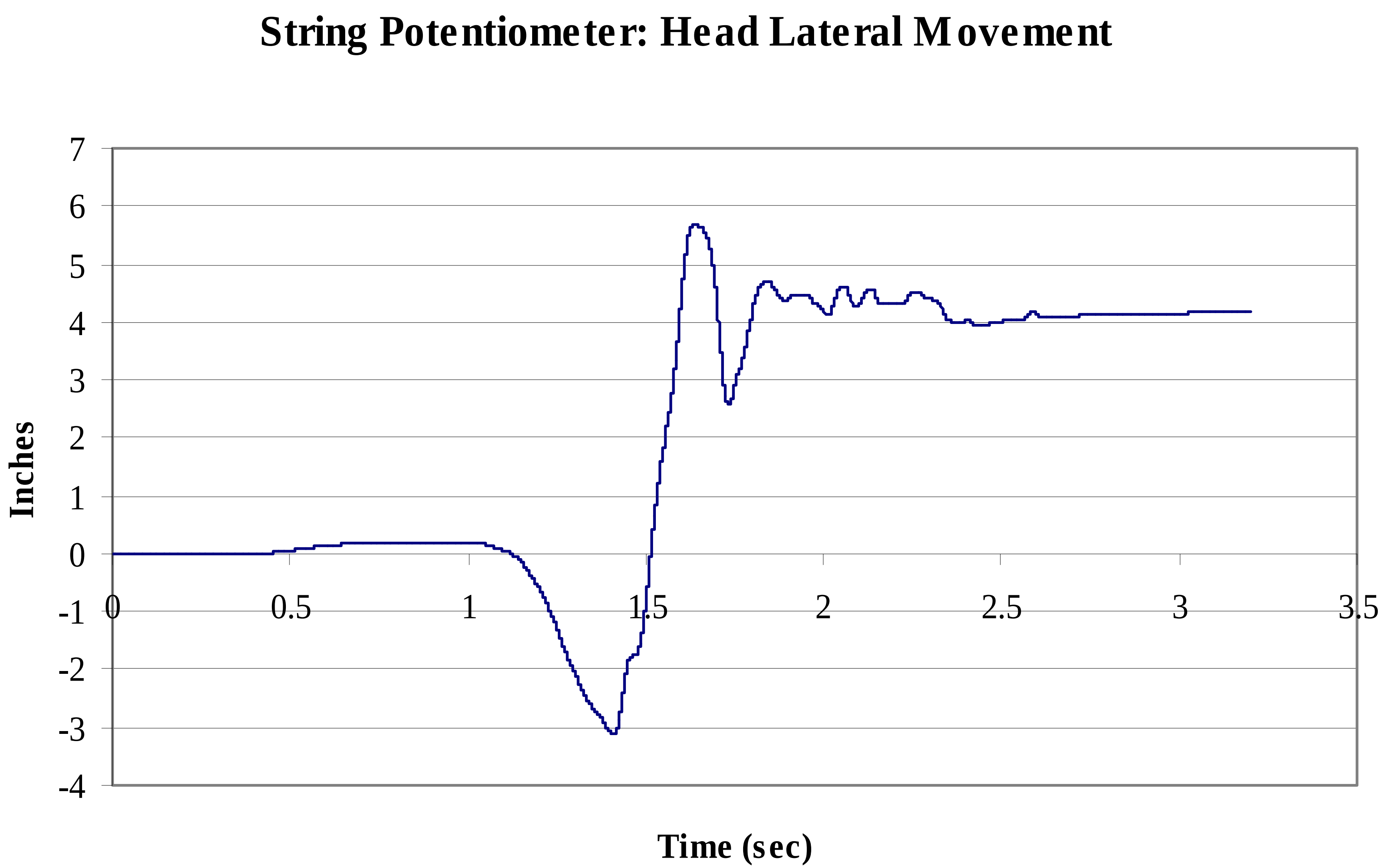

Far Side HIII Dummy Belt and Vertical Neck Loads
Onset of Neck Load
Peak Neck Load = 4,647 N
Load (lbs)
Load (N)
Roll Angle (deg)
150
120
90
60
30
0
-30
5000
4000
3000
2000
1000
0
-1000
175
177
179
181
183
185
187
189
191
193
195
Lap Belt Load
Torso Belt Load
Neck Load, Fz



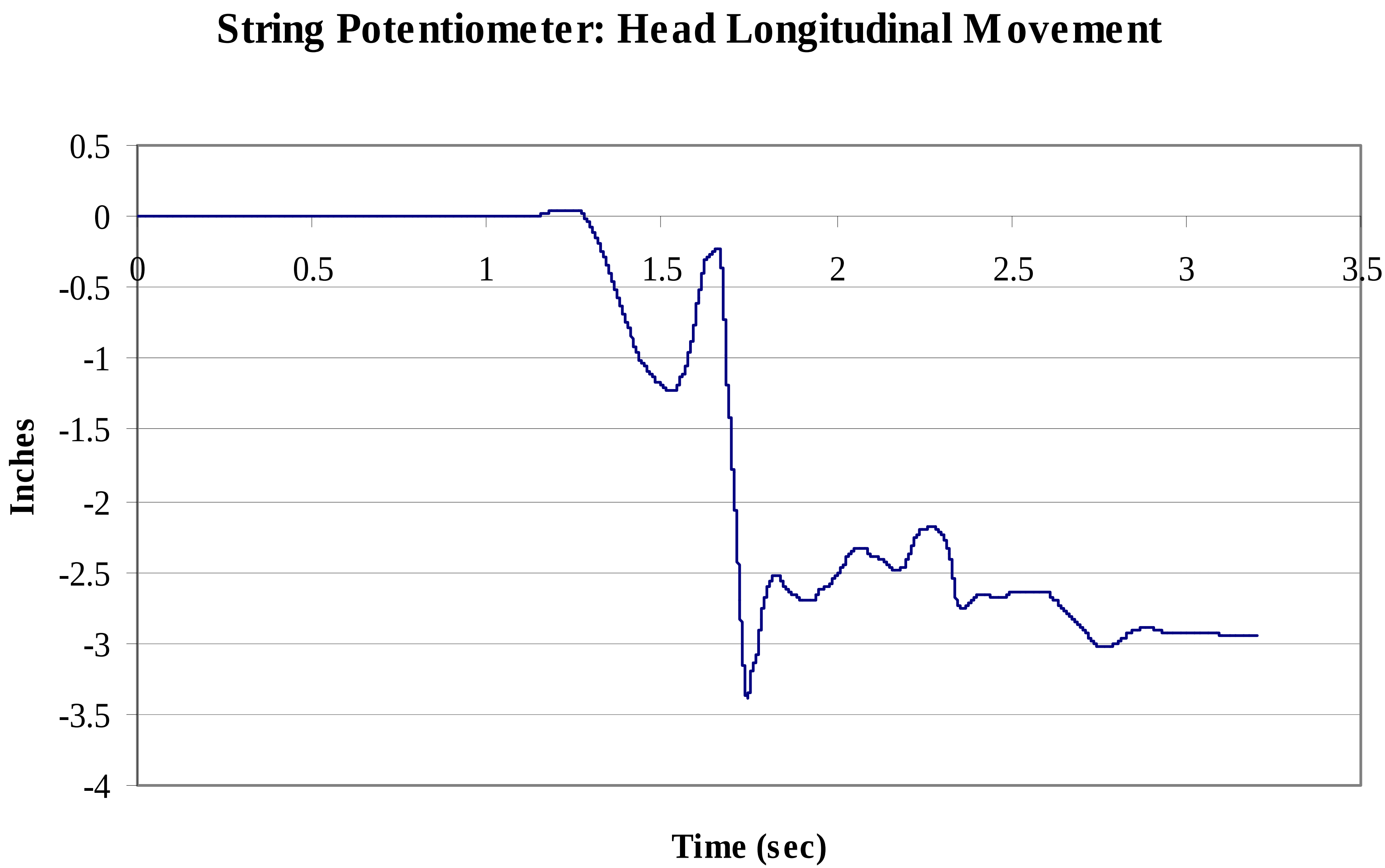
Road Bed Contact at 140° accelerates roll rate



Accelerating roll rate reduces road speed after energy transfer



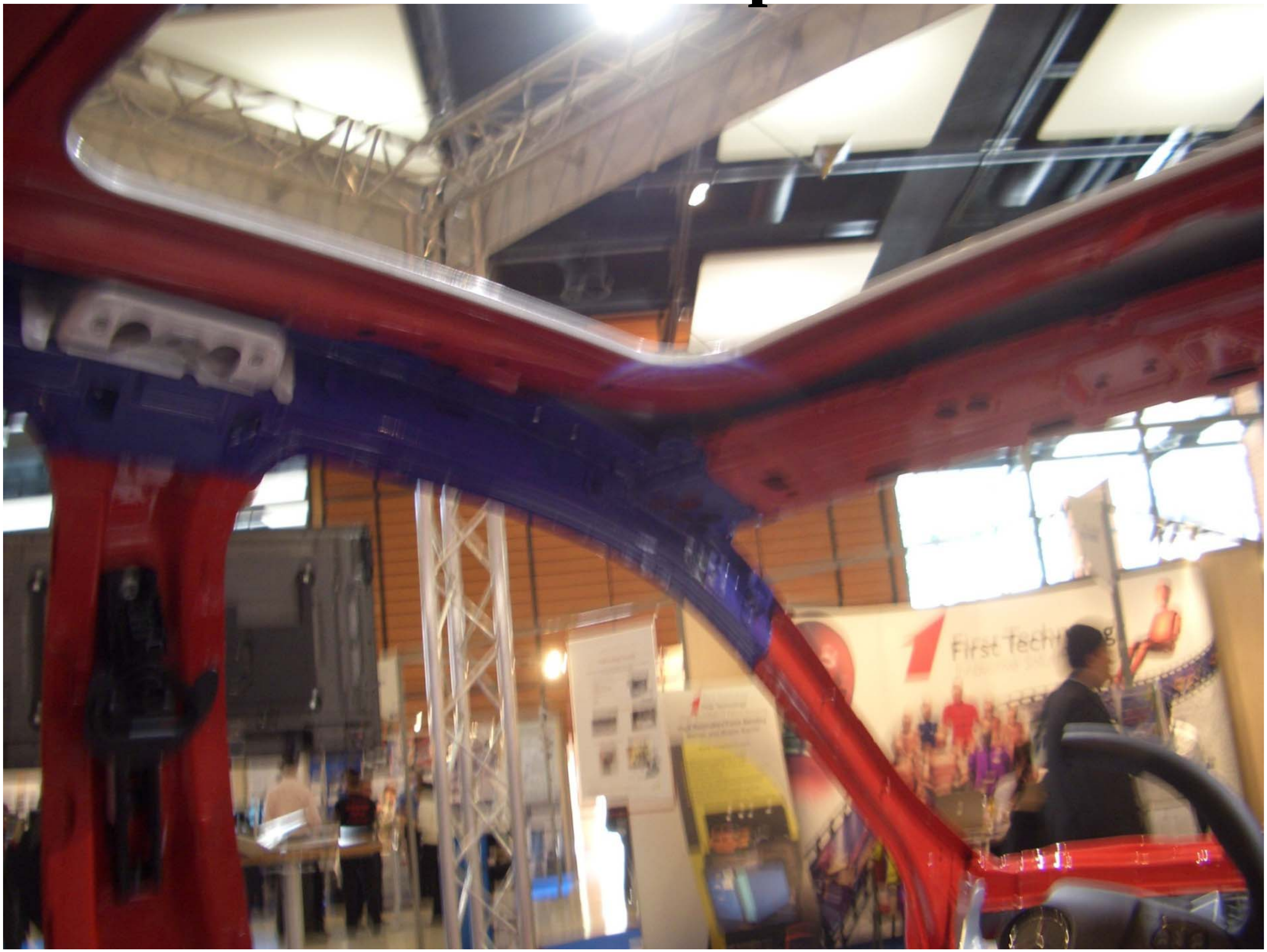
Minus motion of driver dummy towards passenger side



Minus driver head motion is in flexion

Mercedes 2007 C- Class HSS Structure

C- Class HSS Roof Rail/A-pillar/Header Joint



C- Class Window Curtain Air Bag

Table 1. NHTSA Roof Strength to Weight Ratio (SWR) vs. Platen Displacement Related to JRS Testing										
Vehicle			FMVSS 216	M216	Jordan Rollover System Test Data					
Make	Model	Year Range	SWR	M216	JRS Test	Injury Measure	JRS Test	Injury Measure	Comments	JRS Compliance
Subaru	Forester	2007-1998	5.0 @ 3"		18 MPH, 10°	7.6 MPH	12 MPH, 10°	6.5 MPH	Sequence of two tests. Second with dummy.	Acceptable with retained glazing
Toyota	Corolla	2002-1998	4.3 @ 3.4"	1.26	15 MPH, 5°	4.0 MPH	15 MPH, 5°	5.1 MPH		
Toyota	Corolla	2002-1998	4.3 @ 3.4"	1.26	15 MPH, 10°	7 MPH	20 MPH, 10°	10.4 MPH	After 2 JRS tests at 5°.	Unacceptable at 10° Pitch
Toyota	Corolla	1994	2.5 @ 3.5"	1.13						
Nissan	Xterra	2004-2000	3.9 @ 2.6"	0.98	15 MPH, 10°	10.4 MPH	15 MPH, 10°	10.2 MPH	Buck without roof rack; After M216, JRS at SWR = 3.2	Unacceptable
Volvo	XC90	2007-2003	3.5 @ 3"	2.13	15 MPH, 5°	3.8 MPH	15 MPH, 5°	4.1 MPH	Black; After M216 Test	
Volvo	XC90	2007-2003	3.5 @ 3"	2.13	15 MPH, 5°	2.3 MPH	15 MPH, 5°	3.0 MPH	White	
Volvo	XC90	2007-2003	3.5 @ 3"	2.13	15 MPH, 10°	6.9 MPH			White; After 2 JRS tests at 5°	Acceptable
Nissan	Sentra 2 Door	1999-1995	2.8 @ 3.1"		15 MPH, 5°	9.6 MPH	N/A	N/A		Unacceptable
Hyundai	Sonata	2005-1999	2.8 @ 4"		15 MPH, 5°	6.1 MPH	15 MPH, 5°	8 MPH		Unacceptable
Mitsubishi	Eclipse	1994-1990	2.5 @ 3.3"	1.17	15 MPH, 5°	12.1 MPH				Unacceptable
Kia	Sorento	2007-2003	1.9 @ 3"		15 MPH, 5°	9 MPH	15 MPH, 5°	9 MPH		Unacceptable
Jeep	Grand Cherokee	2004-1999	1.7 @ 3.6"		18 MPH, 10°	12.9 MPH	12 MPH, 10°	N/A	Second with dummy	Unacceptable
Jeep	Grand Cherokee	1998-1993	2.3 @ 3.8"	0.98	12 MPH, 5°	4.7 MPH	14 MPH, 5°	8 MPH	Buck; After M216, first JRS at SWR = 3.4, Then at 2.5	Unacceptable
Ford	Explorer	2001-1995	1.9 @ 3"	0.72	15 MPH, 5°	12.1 MPH	15 MPH, 5°	9 MPH		Unacceptable
Isuzu	VehiCROSS	2001-1999			15 MPH, 5°	11.1 MPH	15 MPH, 5°	8.6 MPH		Unacceptable
Isuzu	Rodeo	1997-1991	1.9 @ 5"	1.15	15 MPH, 5°	10.4 MPH	15 MPH, 5°	9.7 MPH	Buck; After M216, first JRS at SWR = 1.6 Then, at 1.6 again.	Unacceptable
GMC	Jimmy	2001-1995	1.5 @ 5"	0.69	15 MPH, 5°	9.8 MPH	15 MPH, 5°	8.3 MPH		Unacceptable
Chevy	S-10 Blazer	2005-1995	1.5 @ 5"	0.76	15 MPH, 5°	10.1 MPH	N/A	N/A		Unacceptable
Chevy	Suburban	2006-2000	1.6 @ 3.2"		15 MPH, 10°	7.7 MPH				Unacceptable
Land Rover	Discovery	2004-1999	1.7 @ 3"		15 MPH, 5°	9.3 MPH	15 MPH, 5°	9.5 MPH	Rear seat 5th percentile dummy	Unacceptable
Chevy	Suburban	1999-1992	1.9 @ 4.9"	0.69	15 MPH, 5°	10.8 MPH	N/A	N/A	Buck; JRS at SWR = 2.1	Unacceptable
Chevy	Silverado 2500 HD	2007-1999	2.5 @ 5"	1.02	15 MPH, 5°	8.4 MPH	15 MPH, 5°	8.3 MPH		Unacceptable

All SWR data @ unloaded vehicle weight (SWR). Maximum UVW (MUVW) reduces the SWR by 20% and increases injury potential accordingly.

Injury potential measures of less than 7 MPH have a low probabilty of serious injury.

Injury potential measures of more than 7 MPH and less than 10 MPH have a high probability of serious injury.

Injury potential measures of more than 10 MPH have a high probability of severe to fatal injury.

Population Effected

	PRIA		Revised Assessment	
Population Affected	Serious	Fatal	Serious	Fatal
No fixed collision on top	19,000	7,426	19,000	7,426
Not totally ejected	13,000	3,559	18,000	6,500*
Using safety restraint	9,600	2,026	17,000	6,100†
Front outboard seats	9,000	1,780	16,000	5,900
Not 12 years or older	9,000	1,764	16,000	5,900‡
Roof Component Intrusion	7,100	1,030	14,000	4,700§
Head/neck/face Injury from intruding	2,400	751	14,000	4,700
Sole MAIS Injury	**800**	**225^**	**14,000**	**4,700**

Note: Occupants who have the potential to benefit from a strong roof are shown in bold type.

Table 1. Revised estimates of the population affected in comparison with the NPRM by improved roof crush resistance based on the PRIA Table IV-2.

5th Percentile Adult (10yr old child) Dummy in Rear Seat

JRS Insights to Occupant Protection

Near side Window Curtain Airbag

Far side 10º Pitch Intrusion w/ buckled header

Conclusion

The JRS can compare the injury and ejection potential of vehicles and occupant protection devices in rollovers and can definitively test vehicle safety components and their causal relationship to decreasing death and injury in crashes or tests.

NHTSA-CFIR Activities

- 2001 – NHTSA legislatively directed to evaluate dynamic rollover testing
- 2001 – 2005 – CFIR submits 28 comments to the NHTSA 1999-5572 Docket.
- 2005 – NHTSA dynamic rollover evaluation incomplete and requests additional data. CFIR submits 6 additional comments to NHTSA 2005-22143 Docket.
- CFIR briefs NHTSA on December 8, 2006 in Washington, DC (and submits confidential detailed electronic data on 10 production vehicles to NHTSA)
- December 9, 2006 – CFIR briefs United States House and Senate Congressional committees with NHTSA oversight
- December 11, 2006 – CFIR briefs Insurance Institute for Highway Safety (IIHS)
- February 23, 2007 CFIR briefs NHTSA in Santa Barbara, California on detailed responses to NHTSA concerns

NHTSA-CFIR Activities - Continued

- March 8, 2007 CFIR briefs NHTSA at NCAP hearing in Washington, DC. Indications are that timing for dynamic legislative response is too tight, research will take too long, increased Strength to Weight Ratio (SWR) static compliance will continue.
- May 2007 – NHTSA requests authorization for a Supplementary Notice of Proposed Rule Making (SNPRM) extending final rule until October 2008
- June 8, 2007 – CFIR submits correlation of intrusion speed and dummy Nij injury measures, comparison of FMVSS 216 compliance versus JRS dynamic injury and ejection potential acceptability for 17 production vehicles, recommends that JRS or finite element dynamic tests establish the static criteria for compliance, as well as four ESV papers summarizing results of JRS Testing