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"Fighting Photos with Photos:"
Using Exemplars from the National Automotive Sampling System (NASS) to Mitigate the Effect of Low Damage Impact Case Photos

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A common approach used by many defense attorneys when defending a low-damage rear impact case is to show photos of the collision, and then to argue that low damage implies minor force. Undefended, that is a convincing argument, and it is often not possible to prevent the low-damage images from being introduced as evidence. However, there is an easy answer to such claims. Without resorting to a full-fledged analysis or reconstruction, it is very often possible to find one or more damaged vehicles of the same make and model whose changes in velocity – delta-v – have been calculated by independent reconstructionists. Such exemplars can be found very easily by perusing the National Automotive Sampling System – NASS, available online at http://www-nass.nhtsa.dot.gov/BIN/NASSCASELIST.EXE/SETFILTER?CASETYPE=PUBLIC

The main NASS webpage states the following: "NHTSA is authorized by congress (Volume 489, United States Code Chapter 301 Motor Vehicle Safety, Section 30166, 30168 and Volume 23 , Section 403) to collect information on motor vehicle crashes to aid in the development, implementation and evaluation of motor vehicle and highway safety countermeasures… Agency procedure for release, accuracy and security of research data collected under the NASS program prohibit the dissemination of any information collected, assembled, derived or computed until all conditions of data gathering and reporting, case completeness, quality control and privacy have been completed. The cases available through the NASS web query system have met these conditions." There are two important consequences of this statement: (1) The data and reconstructions contained in the NASS database were developed for purposes other than litigation. (2) The data and reconstructions contained in the NASS database have been independently vetted for accuracy prior to their release to the public. For these reasons, I have found judicious use of NASS exemplars indispensible in developing a credible rebuttal to the "low damage equals low force" argument.

The following example is from a Texas case in which a 1990 Honda Accord rear-ended a 2003 Ford Ranger. Although the party in the struck Ford Ranger claimed injury, the visible damage that resulted from the collision minimal, especially on the "target" vehicle struck from behind. Images of the vehicles involved in this collision are shown in Fig. 1. Note that although the images were of relatively low quality, it is possible to make out the contour of the hood deformation on the Honda Accord, as well as the downward rotation of the bumper on the Ford Ranger.

In order to find similarly damaged exemplar vehicles, the NASS database was searched by using a variety of pull-down menus (Fig. 2). To effectively search for exemplars, all that needs to be known is the range of vehicle years to be searched, location of primary vehicle damage (e.g. front, back), and vehicle make and model. Note that most vehicles are produced for many years before they are redesigned, so appropriate exemplar vehicles do not have to be from exactly the same model years as those involved in the impact. Vehicle information can be obtained from manufacturer's websites, although I have found the information contained on Wikipedia.org for individual makes and models to be quite comprehensive.

Fig. 1: 1990 Honda Accord with front-end damage (left) and 2003 Ford Ranger XL with rear-end damage (center and right).

 In the first NASS screen shot shown below (Fig. 2), I have entered information necessary to search for series 1990-1993 Honda Accord vehicles containing frontal damage. Fig. 3 shows the first 40 cases returned by the query, identified by case number. Clicking on a case number will allow selection from among a number of screens containing various case details. The most important of these include the *Vehicle* (Fig. 4) and *DeltaV* (Fig. 5) tabs. The *Vehicle* tab contains information that includes vehicle identification number (VIN), vehicle weight, make and model. The *DeltaV* tab contains the change in speed induced by the collision, as well as the energy absorbed by the impact. Note that there are separate sets of tabs for every vehicle involved in a particular collision (and associated with a particular case number).

Energy absorption is calculated from the direct six-point crush measurements taken from the front bumper of the vehicle, and is therefore a direct, quantitative indication of the vehicle damage. Vehicles displaying similar levels of damage are expected to have similar energy absorption levels. Absorbed energy (and hence damage level) does not depend upon the other vehicle(s) in the collision. In contrast, delta-v, the speed change induced by the impact, is a function of many parameters that include vehicle weight(s), coefficient of restitution, exact impact angle, etc. Delta-v is typically expressed in terms of two components: longitudinal (directed front to back along the vehicle axis)and lateral (directed from side to side). As most front-to-rear impacts will involve primarily longitudinal changes in speed, it is important to select exemplar vehicles whose delta-v components are primarily longitudinal in nature, as is true for the exemplar vehicle shown in Figs. 4 and 5.   While absorbed energy directly scales with physical damage for a particular make and model of vehicle, there is less of a correlation between measured physical damage and calculated delta-v. **This shows that vehicle damage alone cannot be used to negate the possibility of a significant induced delta-v, as vehicles with the same degree of damage often have significantly different induced delta-v values.**

Photographs of the vehicle exemplars are can be obtained through the *Components Page* menu, located on the bottom right of both the *Vehicle* and *DeltaV* page tabs. For most cases, a variety of views is available for each damaged vehicle. In some cases, the only available images are of partially or fully repaired vehicles. I have not found such cases to be particularly useful, and have tried to only use

National Automotive
Sampling System
PUBLIC AVAILABILITY OF CASES

- Case Summary
- Components
- Images
- Sketches

NHTSA is authorized by congress (Volume 489, United States Code Chapter 301 Motor Vehicle Safety, Section 30166, 30168 and Volume 23 . Section 403) to collect information on motor vehicle crashes to aid in the development, implementation and evaluation of motor vehicle and highway safety countermeasures. The law requires the Agency to protect the privacy of individuals involved in crashes investigated. Agency procedure for release, accuracy and security of research data collected under the NASS program prohibit the dissemination of any information collected, assembled, derived or computed until all conditions of data gathering and reporting, case completeness, quality control and privacy have been completed. The cases available through the NASS web query system have met these conditions.

SELECT A SINGLE CASE

Case ID [ ] Get Case OR Case Year 1997 ▼ PSU 02 ▼ Case Number [ ] Get Case

SELECT FROM A LIST OF CASES BASED ON CRITERIA BELOW

Crash Criteria

Year All ▼   Max # Vehicles All ▼

Month All ▼   Min # Vehicles All ▼

Mortality/Injury Severity All ▼

Vehicle Criteria

Make HONDA ▼   Start Model Year 1990 ▼

Model ACCORD ▼   End Model Year 1993 ▼

Body Category All ▼

Vehicle Damage

Primary F Front ▼   PDOF [ ] to [ ] degrees

Secondary
All
D Distributed - side or end
L Left - front or rear   Delta V [ ] to [ ] ○ mph ● kmph
(multi select) C Center - front or rear   Barrier Equivalent Speed [ ] to [ ] ○ mph ● kmph

Rollover ☐

Occupant

Age [ ] to [ ] ○ months ● years   Sex All ▼

Seat Position
All
Front Row Left   Height [ ] to [ ] cm
Front Row Middle
Front Row Right   Weight [ ] to [ ] kg

Injury

Body Region
All
Head   AIS/NASS Code [ ]
Face
Neck   Maximum AIS [ ] to [ ]

ISS [ ] to [ ]

Restraint Use

Manual Belt Available All ▼   Air Bag Available All ▼

Manual Belt Used All ▼   Air Bag Location All ▼

Automatic Belt Available All ▼   Air Bag Deployed All ▼

Automatic Belt Used All ▼   Child Seat Used All ▼

Get Case List   Reset Filters

Fig. 2: Screen-shot from NASS search for 1990-93 Honda Accord vehicles with front damage.

Select Case...

Cases Found: 324   Cases This Page: 40

#	Case #	Vehicles	Max Severity	Fatal	Child Seat	Air Bag Deployed	Case ID#
1	1997-004-044 K	2	5	No	Yes	Yes	654700277
2	1997-009-006 K	1	3	No	No	Yes	471400104
3	1997-009-068 B	3	7	Yes	No	No	655700385
4	1997-009-091 K	1	3	No	No	Yes	471400448
5	1997-009-098 J	2	3	No	No	Yes	471400467
6	1997-011-199 H	1		No	No	No	655800494
7	1997-013-199 F	2	1	No	No	No	657000464
8	1997-043-116 D	2	1	No	No	No	658400343
9	1997-043-169 H	2		No	No	No	658400424
10	1997-045-001 F	2	1	No	No	Yes	658900063
11	1997-045-090 B	2	4	Yes	No	Yes	658900261
12	1997-049-008 K	1	3	No	No	No	626400102
13	1997-074-017 F	2	1	No	No	No	660300144
14	1997-074-093 K	1	2	No	No	Yes	660300324
15	1997-075-194 J	4	3	No	No	Yes	916800532
16	1997-079-143 K	2	1	No	No	Yes	921700510
17	1997-079-184 F	2	1	No	Yes	No	921700581
18	1997-079-193 K	3	2	No	No	No	661400598
19	1997-082-065 D	2	2	No	No	No	662100264
20	1997-082-069 D	2	2	No	No	No	661800282
21	1997-082-125 F	2	1	No	No	Yes	662100384
22	1998-002-085 F	2	1	No	No	No	300703
23	1998-002-166 F	1	1	No	No	Yes	102001282
24	1998-004-002 F	2	1	No	No	Yes	654500682
25	1998-006-074 K	2	2	No	No	Yes	655200599
26	1998-006-154 K	2	2	No	No	Yes	119000683
27	1998-008-003 K	1	7	No	No	Yes	655400701
28	1998-008-103 F	2	2	No	No	No	125000876
29	1998-009-076 D	2	1	No	No	No	129000665
30	1998-011-086 H	1		No	No	No	655800652
31	1998-041-076 B	1	4	Yes	No	Yes	657400615
32	1998-041-101 D	2	1	No	No	No	153000680
33	1998-043-030 E	2		No	No	No	658400785
34	1998-043-043 K	3	3	No	No	Yes	908500828
35	1998-043-088 B	2	5	Yes	No	Yes	658400906
36	1998-043-164 F	3		No	No	No	658401019
37	1998-043-175 K	1	3	No	No	No	161001046
38	1998-045-043 K	2	5	No	No	No	658900585
39	1998-049-209 H	2	2	No	No	No	175000872
40	1998-073-006 D	2	1	No	No	No	471900449

Return to Case Query Page   ▷ Next

Fig. 3: Screen shot showing results of search depicted in Fig. 2. Note that there are 324 cases of 1990-93 Honda Accord vehicles indicating frontal damage.

General Vehicle, Case 1999-049-206/Vehicle 2 (CaseId: 175001969, VehicleId: 651091806)

Vehicle | Specifications | Official Records | PreCrash | Driver | AOPS | Rollover | Reconstruction | DeltaV

Identification

Number	2	Identification Number	1HGCB7664M
Model Year	1991	Vehicle Special Use	No Special Use
Make	HONDA	In Transport	X
Model	ACCORD		
Body Category	Automobiles		
Body Type	4-door sedan, hardtop		
Class	Intermediate (wheelbase >= 265 but < 278 cm)		

Weight | **Inspection**

Curb Weight	1242 kgs/ 2738 lbs	Type of Inspection	Complete Inspection
Source	Automotive News		
Cargo Weight	0		
Source	Vehicle inspection		

Exterior Interior Safety

Return to Case Query Page   Vehicle Select Page   Components Page

Fig. 4: *Vehicle* tab, which shows parameters including vehicle make, model and year; VIN; and weight.

General Vehicle, Case 1999-049-206/Vehicle 2 (CaseId: 175001969, VehicleId: 651091806)

Vehicle | Specifications | Official Records | PreCrash | Driver | AOPS | Rollover | Reconstruction | DeltaV

Highest Severity Impact   Event Number   1

Basis for Delta V   SMASH - Missing vehicle

Computer Generated Delta V

Total	19 kmph/ 12 mph	Energy Absorption	12604 joules
Longitudinal Component	-19 kmph/ -11 mph	Impact Speed	998 kmph/ 620 mph
Lateral Component	-3 kmph/ -1 mph		
Confidence Level	Collision fits model - results appear reasonable		

Barrier Equivalent Speed   15 kmph/ 9 mph

Estimated Delta V

Researcher Determined   Reconstruction Delta V coded

Exterior Interior Safety

Return to Case Query Page   Vehicle Select Page   Components Page

Fig. 5: *DeltaV* tab, which includes calculated induced velocity components, as well as Energy Absorption calculated from direct crush measurements.

vehicle images that show evidence of the systematic, six-point crush measurements described by Cooper and Fricke.

Over the five years I've used the NASS database, I have not found an easy way to automate the exemplar search method. While more popular vehicle models (like the 1990 – 1993 Honda Accord and 1998 – 2008 Ford Ranger vehicles discussed herein) may each return hundreds of potential exemplars, only few instances of other vehicles (e.g. Infiniti Q45 Series 2002 – 2006) may be contained in the NASS database. (For such cases, I look for either corporate twins, or vehicles of similar size, weight and bumper design.) Regardless, for front-to-back collisions, I try to find exemplars with damage that has the following characteristics: (1) primarily longitudinal velocity components; (2) measurement posts present in the photos; (3) point of contact on bumper, with little-to-no evidence of over-ride. Exemplars from the NASS database with damage similar to the 1990 Honda Accord shown in Fig. 1 are contained in Fig. 6; exemplars from the NASS database with damage similar to the 2003 Ford Ranger (series 1998 – 2008) shown in the same figure are contained in Fig. 7.

1990, U = 12311 J; Δv = -13 mph Case 1997-043-116	1991, U = 12604 J; Δv = -11 mph Case 1999-049-206	1991, U = 10631 J; Δv = -10 mph Case 2002-079-004
1993, U = 10764 J; Δv = -6 mph Case 2005-074-054	1993, U = 13316 J; Δv = -10 mph Case 2003-002-050	1990, U = ? J; Δv = -? (Actual vehicle, from Fig. 1)

Fig. 6: Five exemplar 1990-1993 Honda Accord vehicles, plus the subject Honda Accord (lower right). Note the similar visible damage and similar measured values for dissipated energy (U) for each of the exemplars.

1998, U = 9897 J; Δv = 7 mph Case 2007-074-158	2002, U = 13217 J; Δv = 9 mph Case 2006-081-061	1999, U = 12225 J; Δv = 9 mph Case 1999-043-183
2002, U = 9845 J; Δv = 8 mph Case 2004-076-050	2000, U = 12313 J; Δv = 9 mph Case 2002-047-141	1990, U = ? J; Δv = ? (Actual vehicle, from Fig. 1)
Fig. 7: Five exemplar 1998-2008 Ford Ranger vehicles, plus the subject Ford Ranger (lower right). Note the similar visible damage and similar measured values for dissipated energy (U) for each of the exemplars.		

Based on my analysis and reconstruction that used the NASS case data shown above, the case involving the Honda Accord and the Ford Ranger settled prior to trial.

Using this approach to mitigate the "minor damage/low force" argument is effective for the following reasons:

- Vehicles of the same make, model and series are used as exemplars.
- Multiple exemplars reconstructed by independent investigators working at different times and locations result in similar values of dissipated energy (U) for vehicles displaying similar levels of damage.
- Impact-induced delta-v values show that the impact forces are significant. Typically, delta-v values of 5 – 10 mph correspond to impact-induced g-forces of between 1.8 g – 3.6 g applied to the rear bumper of the struck vehicle. This level of average "g-force" assumes impact duration of about 0.125 seconds, which is typical for a low-damage front-to-rear impact [Brach].
- As mentioned above, the NASS reconstructions were not developed for litigation purposes. The exemplars are maintained in a government database administered by the United States Department of Transportation.

Bibliography

G.W. Cooper and L.B. Fricke, "Work, Energy, and Speed from Damage in Vehicle Crashes," Chapter 10 in *Traffic Crash Reconstruction*, second edition. Northwestern University Center for Public Safety, Evanston, IL, 2010.

R.M. Brach and R.M. Brach, *Vehicle Accident Analysis and Reconstruction Methods,* SAE International, Warrendale, PA, 2005.