APPENDIX

Comparisons of Pre-MY 98 to MY 98/99 Air Bags

Chapter II provided some analysis of MY 98 air bags to pre-MY 98 air bags. In particular, estimates were made using SCI cases that the fatality rate for out-of-position (at-risk) occupants for MY 98 air bags is about 30 percent of the fatality rate for pre-MY 98 air bags. In addition, it was estimated that there was no statistically significant difference in overall fatalities between pre-MY 98 and MY 98 air bags. This appendix analyzes additional real world fatality data and compares pre-MY 98 air bag equipped vehicles to MY 98 air bag equipped vehicles. It also examines high speed test data to determine how well the MY 98 and MY 99 air bag vehicles perform compared to pre-MY 98 air bags.

Analysis of 1998 FARS Data and Redesigned Air Bags

The agency conducted several analyses using 1996 to 1998 FARS data to examine the question of how well MY 1998 redesigned air bags are performing. The only data available from FARS for the redesigned MY 1998 vehicles are in FARS 1998. Thus, the analysis compares the fatality rate of MY 1998 vehicles in FARS 1998 to the fatality rate of MY 1997 vehicles in FARS 1997, and to the fatality rate of MY 1996 vehicles in FARS 1996[1].

[1] This analysis does not control for the increase in belt use over time or the change in seating behavior of children moving from the front seat to the rear seat.

Polk has data on the number of registered vehicles. Unfortunately, the latest data available from Polk (July 1, 1998) do not have the total number of MY 1998 vehicles registered, since many MY 1998 vehicles are registered after July 1, 1998. Polk data for July 1, 1997 indicate that there were 13.10 million MY 1996 vehicles registered. Polk data for July 1, 1998 indicate there were 14.17 MY 1997 vehicles registered and 10.05 MY 1998 vehicles registered. Based on the MY 1997 vehicles, the July 1, 1997 Polk data, would have to be multiplied by 1.45 to get an estimate of the total on July 1, 1998. Thus, our best estimate of total registrations for MY 1998, until the July 1, 1999 tables are available, would be 14.57 million vehicles (10.05 x 1.45).[2] Note that light truck registrations increased significantly from MY 1996 to MY 1998. All of these vehicles were equipped with frontal air bags for both the driver and right front passenger. An estimated 87 percent of the MY 1998 vehicles had redesigned air bags. Since at this time, each VIN number must be looked up by hand to determine whether it was a redesigned air bag or not, in this analysis, all MY 1998 vehicles are taken together without separating them for redesigned air bags.

[2] Total sales of passenger cars and light trucks in calendar year 1996 and 1997 were essentially the same; 1998 sales were slightly higher. There were 15.14 million sales in 1996, 15.16 million sales in 1997, and 15.55 million sales in 1998. However, calendar year sales do not match model year sales, so the best analysis is to compare fatalities by vehicle model year with registrations by model year. The calendar year data are presented to show that, if anything, the MY 1998 projection of 14.57 million registrations is low and that the fatality rates for MY 98 vehicles shown in the tables might be slightly high.

Table A-1
Polk Data
(In millions)

	Passenger Cars	Light Trucks	Total
MY 1996	7.695	5.408	13.103
MY 1997	8.049	6.125	14.174
MY 1998 estimated	8.053	6.516	14.569

Fatalities in frontal impacts

An analysis of 1996 to 1998 FARS found essentially the same number of fatalities in frontal impacts for MY 1996 vehicles in 1996 FARS (730), as in MY 1997 vehicles in 1997 FARS (776), as in MY 1998 vehicles in 1998 FARS (732). Passenger car fatalities decreased, while light truck fatalities increased. In addition, frontal impacts were in the range of 48 to 50 percent of fatalities for that group for all three years examined.

Table A-2
Fatalities in Frontal Impacts (FARS Data)

	Passenger Cars	Light Trucks	Total
MY96 in FARS 96	448	282	730
MY97 in FARS 97	450	326	776
MY98 in FARS 98	414	318	732

Note: If the number of fatalities were adjusted for belt use increases discussed on Page II-25 between 1996 and 1998, the number of fatalities would be 689 for MY 96 in FARS 96, 753 for MY 97 in FARS 97 and 732 for MY 98 in FARS 98. This would make the fatality rates in Table A-3 be 53 for MY 96 in FARS 96, 53 for MY 97 in FARS 97 and 50 for MY 98 in FARS 98.

Dividing fatalities in frontal impacts by registered vehicles results in Table A-3. Light trucks have lower fatality rates in frontal impacts than passenger cars. Assuming that our estimate of the number of MY 1998 registered vehicles is reasonable, it appears that fatality rates for both passenger cars and light trucks are lower with MY 1998 vehicles than for MY 1997 or MY 1996.

Table A-3
Frontal Fatalities per Million Vehicles Registered

	Passenger Cars	**Light Trucks**	**Total**
MY96 in FARS 96	58	52	56
MY97 in FARS 97	56	53	55
MY98 in FARS 98	51	49	50

Calculated for example:
MY 1996 - 730 fatalities/13.10 million vehicles = 56 fatalities per million vehicles

Based on testing with dummies, past agency assessments indicated the possibility that redesigned air bags may not provide full protection for unbelted occupants during high speed impacts. Thus, the same analysis was performed for drivers and right front passengers and for belted and unbelted occupants. The fatality rate appears to have decreased for unbelted right front seat occupants. With one exception, the fatality rate appears to have decreased or remained the same between MY 1996 and MY 1998. The only exception was belted light truck drivers. In order to get a better understanding of the potential reduction in the fatality rate for unbelted right front seat occupants, the fatalities were divided by ages 0-12 and 13 and over. Table A-4 shows a decrease in child deaths from 35 in MY 96 vehicles to 29 in MY 98 vehicles, but it also shows a larger decrease in the number and fatality rate of right front seat occupants of ages 13 and above from 240 deaths in MY 96 vehicles down to 203 deaths in MY 98 vehicles. So, the data indicate the reduction in fatality rates comes mainly from unbelted right front seat occupants age 13 and above.

Driver Fatalities in Frontal Impacts by Weight and Height of the Driver

Dummy crash test data tend to indicate that redesigned air bags may not be as effective as pre-redesigned air bags in higher speed crashes. The analysis was performed to investigate the theory that redesigned air bags may not have enough power for heavier and taller occupants. Dummy crash test data to date indicate the worst case would be an unrestrained heavier right front passenger, and that the difference for drivers and restrained right front passengers would be minimal. Unfortunately, data on right front passengers by height and weight are not available on FARS. The 1998 FARS data, for the first time, have been linked to State driver license data, allowing the agency to get weight and height of drivers. MY 1998 and 1999 vehicles were decoded using the VIN data to determine whether the vehicles had redesigned air bags or not. Thus, an analysis was performed using 1998 FARS data and comparing MY 1996 and MY 1997 vehicles before redesign to the redesigned MY 1998 and 1999 vehicles in the file.

Table A-4
Fatalities and Rates* in Frontal Impacts (FARS Data)

	Passenger Cars		**Light Trucks**		**Passenger Cars & Light Trucks**		
	Belted	**Unbelted**	**Belted**	**Unbelted**	**Belted**	**Unbelted**	**Total**
Drivers							
MY96 in FARS 96	148 (19)	139 (18)	58 (11)	110 (20)	206 (16)	249 (19)	455 (35)
MY97 in FARS 97	156 (19)	144 (18)	78 (13)	139 (23)	234 (17)	283 (20)	517 (36)
MY98 in FARS 98	138 (17)	133 (17)	89 (14)	140 (21)	227 (16)	273 (19)	500 (34)
Front-Outboard Passengers							
MY96 in FARS 96	61 (8)	100 (13)	39 (7)	75 (14)	100 (8)	175 (13)	275 (21)
MY97 in FARS 97	63 (8)	87 (11)	40 (7)	69 (11)	103 (7)	156 (11)	259 (18)
MY98 in FARS 98	63 (8)	80 (10)	38 (6)	51 (8)	101 (7)	131 (9)	232 (16)
Total							
MY96 in FARS 96	209 (27)	239 (31)	97 (18)	185 (34)	306 (23)	424 (32)	730 (56)
MY97 in FARS 97	219 (27)	231 (29)	118 (19)	208 (34)	337 (24)	439 (31)	776 (55)
MY98 in FARS 98	201 (25)	213 (26)	127 (19)	191 (29)	328 (23)	404 (28)	732 (50)

* Rate (parenthetical values): fatalities per million registered vehicles.
Note: Due to rounding, the sum of fatality rates for belted and unbelted columns, or drivers and passengers, might not be equal to that in the Total column. .

Table A-5
Front-Outboard Passenger Fatalities and Rates* in Frontal Impacts (FARS Data)

	Passenger Cars		**Light Trucks**		**Passenger Cars & Light Trucks**		
	Belted	**Unbelted**	**Belted**	**Unbelted**	**Belted**	**Unbelted**	**Total**
Child Passengers (Age 0-12)							
MY96 in FARS 96	10 (1)	12 (2)	5 (1)	8 (1)	15 (1)	20 (2)	35 (3)
MY97 in FARS 97	7 (1)	13 (2)	5 (1)	6 (1)	12 (1)	19 (1)	31 (2)
MY98 in FARS 98	10 (1)	10 (1)	3 (0)	6 (1)	13 (1)	16 (1)	29 (2)
Adult Passengers (Age 13 and Older)							
MY96 in FARS 96	51 (7)	88 (11)	34 (6)	67 (12)	85 (6)	155 (12)	240 (18)
MY97 in FARS 97	56 (7)	74 (9)	36 (6)	62 (10)	92 (6)	136 (10)	228 (16)
MY98 in FARS 98	53 (7)	70 (9)	35 (5)	45 (7)	88 (6)	115 (8)	203 (14)

* Rate (parenthetical values): fatalities per million registered vehicles.

Table A-6 shows the weight data (in pounds) for all drivers, belted and unbelted. While the data show there were a higher percentage of fatalities for the heaviest drivers (226 pounds or more) with the redesigned air bags, the difference is not statistically significant.

Table A-6
Driver Fatalities by Weight
Based on FARS 1998

	<=125 lbs.	**126 - 175 lbs.**	**176 - 200 lbs.**	**201 - 225 lbs**	**226+ lbs.**	**Total**
MY 96 and MY 97 vehicles	104 (10.79%)	458 (47.51%)	234 (24.27%)	92 (9.54%)	76 (7.89%)	964 (100%)
redesigned air bag vehicles	36 (11.43%)	139 (44.13%)	78 (24.76%)	29 (9.20%)	33 (10.48%)	315 (100%)

The same analysis for unbelted drivers found a wider spread in the percentage of the heaviest drivers with redesigned air bags, but this difference was not statistically significant.

Table A-7
Unbelted Driver Fatalities by Weight
Based on FARS 1998

	<=125 lbs.	126 - 175 lbs.	176 - 200 lbs.	201 - 225 lbs	226+ lbs.	Total
MY 96 and MY 97 vehicles	55 (10.07%)	254 (46.52%)	139 (25.46%)	54 (9.89%)	44 (8.06%)	546 (100%)
redesigned air bag vehicles	18 (11.18%)	66 (40.99%)	40 (24.84%)	15 (9.32%)	22 (13.66%)	161 (100%)

A similar analysis was performed with driver height. The shorter drivers (5'4" and less) had a lower percentage with the redesigned air bag, however, this analysis found no statistically significant difference by driver height.

Table A-8
Driver Fatalities by Driver Height
Based on FARS 1998

	<= 64 inches	65 - 72 inches	73+ inches	Total
MY 96 and MY 97 vehicles	219 (18.16%)	832 (68.99%)	155 (12.85%)	1,206 (100%)
redesigned air bag vehicles	64 (14.88%)	309 (71.86%)	57 (13.26%)	430 (100%)

The same analysis for unbelted drivers also found no statistically significant differences.

Table A-9
Unbelted Driver Fatalities by Driver Height
Based on FARS 1998

	<= 64 inches	65 - 72 inches	73+ inches	Total
MY 96 and MY 97 vehicles	116 (17.29%)	455 (67.81%)	100 (14.9%)	671 (100%)
redesigned air bag vehicles	27 (12.86%)	159 (75.71%)	24 (11.43%)	210 (100%)

In summary, crash data available to date show no statistically significant difference between pre-MY 1998 air bags and MY 1998 redesigned air bags.

Analysis of MY 98/99 redesigned air bags and chest g s

Chapter IV provides a variety of test data and analysis of redesigned air bags. In past NHTSA analyses,[3] test data were used to project the potential lives saved or not saved by redesigned air bags compared to pre-MY 1998 air bags. The agency focused on chest g s in these analyses, since the biggest impact appeared to be on chest g s, notably the unrestrained passenger chest g s, and since previous agency evaluations showed that chest g s related well to overall injury. This section updates those analyses using the latest information.

[3] Final Regulatory Evaluation, Actions to Reduce the Adverse Effects of Air Bags, FMVSS No. 208, Depowering , NHTSA, February 1997, (see pages IV-13 and IV-37) and
Preliminary Economic Assessment, FMVSS No. 208, Advanced Air Bags , NHTSA, August 1998 (Docket #98-4405-#2) (see pages VIII-5 to VIII-8)

Vehicle Tests

As shown in Chapter IV, matched pair analysis of belted occupants indicate there is little difference in test scores between the pre-MY 1998 and redesigned MY 98/99 air bags. The agency has 6 unbelted 30 mph vehicle matched pair tests of MY 1998 and pre-MY 1998 air bags and 6 additional vehicle matched pair tests of MY 1999 and pre-MY 1998 air bags. These data can be analyzed in different ways depending on the philosophy used. Taking just simple averages of the 6 vehicles chest g s for matched pairs results in the following (60 g s is the proposal):

Table A-10
Comparison of pre-MY 98 to MY 98/99 Vehicles
Chest g s

	PRE MY 1998	MY 1998	MY 1999	Difference
Driver	47.9 g s	45.2 g s		Down 2.7 g's
Driver	41.9 g s		48.3 g s	Up 6.4 g s
Passenger	43.8 g s	48.6 g s		Up 4.8 g s
Passenger	45.6 g s		46.1 g s	Up 0.5 g s

See Tables A-13a through A-13d for data (n=12). Chest g s calculations excluded the confidential MM in Tables A-13c and A-13d.

One could look at these data and decide that there isn t much difference between them. Average driver chest g s were slightly down for the 6 MY 98 vehicles, but up considerably for the 6 MY 99 vehicles. Average passenger chest g s were up considerably for the 6 MY 98 vehicles, but were up only slightly for the 6 MY 99 vehicles. Averaging the 12 MY 98 and MY 99 vehicles, under the assumption that they are all redesigned air bag vehicles, results in the driver chest g s being up 1.66 chest g s and passenger chest g s being up 2.84 g s on average. One could argue that there is really no significant difference between the two types of air bags.

On the other hand, one could argue that theoretically even a 1 g difference in chest g s is important for safety and you could calculate this impact on safety. Under this philosophy, these same data were analyzed model by model to determine the impact on fatalities using Method 2 from the February 1997 Depowering analysis. The results for the driver were almost exactly the same. The average impact on driver fatalities, after considering each model separately and averaging them was a 1.72 percent increase in fatalities.[4] Thus, the data show no significant difference in unbelted 48 kmph (30 mph) test data for the driver side comparing pre-MY 98 air bags to redesigned MY 98 and MY 99 air bags. The same analysis for the passenger side indicated an average increase in fatalities of 3.5 percent for redesigned MY 98 and MY 99 air bags compared to matched pre-MY 98 air bags.

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[4] Method 2 employed Table IV-14 (Page IV-35) from the report Actions to Reduce the Adverse Effects of Air Bags, FMVSS No. 208, Depowering, February 1997." The percentage change (+/-) in driver-side chest g s for each make/model was computed using 48 g s as the denominator. Table IV-14 was used to compute the changes (+/-) in fatality percentage. The net difference in fatality percentages across the pre-MY98 models and the MY98+99 models was obtained and compared.

Based on the two different methodologies used in the 1997 Depowering analysis, the average 2.84 chest g s increase for the passenger side would result in an estimated 9 to 26 lives not saved (under Method 1)[5] and 49 lives that would not be saved (under Method 2)[6] by MY 98/99 air bags compared to pre-MY 98 air bags.

Sled Tests

The agency also performed a group of sled tests using the 95th percentile male dummy to determine whether the MY 98/99 redesigned air bags performed as well as the pre-MY 98 air bags. Table A-9 presents the chest g s data from these tests at 30 and 40 mph. Two sled bucks were used representing a Chevrolet Venture minivan and a Buick Century, equipped with either MY 1997 or MY 1999 redesigned air bags. Table A-9 presents these data for the driver and right front passenger. While there is one large increase (almost 10 g s) in chest g s for the Buick Century passenger at 30 mph, the rest of the data taken together show no real change in chest g s between the MY 97 and MY 99 redesigned air bags.

However, the agency did find a difference in HIC when the test speed was increased to 45 mph on the sled. While chest g s went down with the redesigned MY 99 air bag, HIC went up dramatically from 904 in the MY 97 Century to 1,731 (the initial impact to the windshield resulted in a HIC of 1,538; upon rebound into the B-pillar the HIC was 1,731) in the MY 99

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[5] (Model 1) 2.84 g s x .91 to 2.80 = 2.58 to 7.95%
.66 x 1.0258 to 1.0795 = .677 to .7125, [(.677 to .7125) - .66] = .017 to .0525
unbelted passenger fatals in the 31 to 40 cell = 502, 502 x .017 to .0525 = 9 to 26

[6] (Model 2) Unbelted passenger fatals in the 0-40 mph cells = 1,405
1,405 x .035 = 49

Century at 45 mph. An analysis of the film from these tests found in both cases the 95th percentile male dummy hit the windshield, but the severity of impact was higher with the redesigned air bag. Based on these two vehicles, one could argue that the redesigned air bags are doing a good job up to around 45 mph. Given the data available to date, there appears to be little difference between the pre-MY 98 air bags and the MY 98/99 air bags in terms of high speed crashes up to 40 mph. With 45 mph delta V sled tests, the Buick Century driver chest g s decreased by 9.2 g s and the passenger chest g s increased 0.70 g s compared to a 40 mph delta V.

Table A-11
Driver Sled Test Data with 95th Percentile Dummies
(Chest g s)

Speed/Model Year	Chevy Venture - Driver	Buick Century - Driver	Chevy Venture - Passenger	Buick Century - Passenger
30 mph				
MY 97	32.9	45.6	36.7	40.6
MY99	36.0	44.3	33.7	50.5
40 mph				
MY 97	64.2	54.8	44.5	51.5
MY 99	60.0	59.8	44.5	51.8
45 mph				
MY 97		61.8		55.8
MY 99		52.6		56.5

30 Mph Unbelted Barrier Data: MY99 vs Pre-MY98 and MY98 vs pre-MY98 Comparisons

Table A-12a
MY1998 vs Pre-MY98
48 kmph (30 mph) Unbelted Barrier, 50th Percentile Male Dummy Responses*
DRIVER

Model Year	HIC_{15}	Nij	Chest g s	Chest Deflection (mm)	Test Vehicle Sample (n)
Pre-1998	280	**	47.93	38.63	5-6
1998	205	0.412	47.34	39.96	9

* Average values shown.
** Pre-98 models did not use dummy neck instrumentation.
Make/models were matched.

Table A-12b
MY1999 vs Pre-MY98
48 kmph (30 mph) Unbelted Barrier, 50th Percentile Male Dummy Responses*
DRIVER

Model Year	HIC_{15}	Nij	Chest g s	Chest Deflection(mm)	Test Vehicle Sample (n)
Pre-1998	231	**	44.25	36.0	6
1999	188	0.38	48.44	39.5	6

* Average values shown.
** Pre-98 models did not use dummy neck instrumentation.
Make/models were matched.

Table A-12c
MY1998 vs Pre-MY98
48 kmph (30 mph) Unbelted Barrier, 50th Percentile Male Dummy Responses*
PASSENGER

Model Year	HIC_{15}	Nij	Chest g s	Chest Deflection (mm)	Test Vehicle Sample (n)
Pre-1998	194	**	43.8	20.1	4-6
1998	187	0.415	50.32	15	9

* Average values shown.
** Pre-98 models did not use dummy neck instrumentation.
Makes/models were matched.

Table A-12d
MY1999 vs Pre-MY98
48 kmph (30 mph) Unbelted Barrier, 50th Percentile Male Dummy Responses*
PASSENGER

Model Year	HIC_{15}	Nij	Chest g s	Chest Deflection (mm)	Sample (n)
Pre-1998	247	**	45.7	18.74	6
1999	220	0.453	46.1	16.2	6

* Average values shown.
** Pre-98 models did not use dummy neck instrumentation.
Makes/models were matched.

NOTE: There were 6 - MY99 make/models (VRTC), 7 - MY98 make/models (VRTC) and 2 other vehicles considered [a (confidential vehicle) and a 1998 Ford Escort (non-confidential) for a total of 9 MY98 vehicles]. The other confidential MY data are not included in Tables IV-12a-12d.

30 Mph Unbelted Barrier Comparison by Specific Make/Models (MY99 vs Pre-MY98 and MY98 vs Pre-MY)

Table A-13a
MY99 vs. Pre-MY98 Matched Make/Models
48 kmph (30 mph) Unbelted Barrier, 50th Percentile Male Dummy
DRIVER

Make Model Year	HIC_{15}	Nij	Chest g s	Chest Deflection (mm)
Dodge Intrepid				
Pre-98	239	**	40.6	33.6
1999	403	0.52	54.4	44.8
Saturn				
Pre-98	N.D.	**	33.0	41.3
1999	128	0.41	36.8	46.8
Ford Econoline				
Pre-98	162	**	47.3	31.4
1999	87	0.32	52.1	37.1
Acura 3.5RL				
Pre-98	N.D.	N.D.	N.D.	N.D.
1999***	154	0.29	56.9	31.8
Ford Expedition				
Pre-98	201	**	42.2	27.7
1999	178	0.406	46.73	28.1
Toyota Tacoma				
Pre-98	321	**	46.4	46.9
1999	176	0.333	43.7	48.4

----- Missing data. ** Pre-98 neck loads not measured.
*** 1999 Acura 3.5RL femur axial load exceeded proposed ICPL with a value of 13,349N.

N.D. = data not available.

Table A-13b
MY99 vs. Pre-MY98 Matched Make/Models
48 kmph (30 mph), Unbelted Barrier, 50th Percentile Male Dummy
PASSENGER

Make Model Year	HIC_{15}	Nij	Chest g s	Chest Deflection (mm)
Dodge Intrepid				
Pre-98	212	**	52.4	19.7
1999	223	0.40	54.1	25.7
Saturn				
Pre-98	139	**	41.6	12.8
1999	200	0.50	40.2	9.2
Ford Econoline				
Pre-98	120	**	44.6	13.6
1999	226	0.35	45.8	7.3
Acura 3.5RL				
Pre-98	N.D.	N.D.	N.D.	N.D.
1999	367	0.44	49.8	11.6
Ford Expedition				
Pre-98	361.2	**	43.7	12.1
1999	132	0.34	51.0	19.6
Toyota Tacoma				
Pre-98	N.D.	N.D.	N.D.	N.D.
1999	173	0.69	35.6	23.5

--- Missing data
N.D. = data not available
**Pre-98 neck values not measured.

Table A-13c
MY98 vs. Pre-MY98 Matched Make/Models
48 kmph (30 mph) Unbelted Barrier, 50th Percentile Male Dummy
DRIVER

Make Model Year	HIC_{15}	Nij	Chest g s	Chest Deflection (mm)
Ford Taurus Pre-98 1998	 337 181	 ** 0.38	 50.4 47.2	 33.06 21.9
Dodge Neon Pre-98 1998	 170 166	 ** 0.47	 47.3 43.5	 30.37 24.9
Toyota Camry Pre-98 1998	 159 231	 ** 0.45	 49.0 51.8	 46.2 38.1
Honda Accord Pre-98 1998	 500 51	 ** 0.27	 40.2 36.7	 ---- 45.8
Dodge Caravan Pre-98 1998	 394 350	 ** 0.47	 47.5 48.0	 44.6 54.7
Ford Explorer Pre-98 1998 (VRTC)	 218 272	 ** 0.30	 53.2 44.4	 38.1 32.3
Confidential Make/model				

** Nij neck loads not measured.
----Missing data.

For the driver MY98 vs pre-98MY, for 4 out of 6 vehicles the chest g s decreased an average of -4.8 g s and for 2 out of 6 vehicles chest g s increased an average of +1.65 g s. This is the opposite of the driver for MY99 vs pre-MY98.

Table A-13d
MY98 vs. Pre-98 Matched Make/Models
48 kmph (30 mph) Unbelted Barrier, 50th Percentile Male Dummy
PASSENGER

Make Model Year	**HIC_{15}**	**Nij**	**Chest g s**	**Chest Deflection (mm)**
Ford Taurus Pre-MY98 1998	 167 191	 ** 0.43	 45.6 48.5	 ---- 8.8
Dodge Neon Pre-MY98 1998	 125 297	 ** 0.59	 46.1 **61.4**	 23.6 16.0
Toyota Camry Pre-MY98 1998	 401 236	 ** 0.26	 47.3 35.1	 16.93 16.7
Honda Accord Pre-MY98 1998	 273 160	 ** 0.39	 40.2 45.0	 ----- 13.11
Dodge Caravan Pre-MY98 M1998	 70 249	 ** 0.48	 39.0 53.4	 24.58 20.28
Ford Explorer Pre-MY98 MY98 (VRTC)	 131 186	 ** 0.31	 44.6 48.2	 17.0 10.3
Confidential Make/Model				

** Nij neck loads not measured.
----Missing data
Bold Number indicates measured value exceeds proposed ICPL.

Pass Rates by Response Type: 30 Mph Unbelted Barrier Tests

Table A-14a
Pass Rate - MY98 vs Pre-MY98
48 kmph (30 mph) Unbelted Barrier, 50th Percentile Male Dummy
DRIVER

Model Year		n	HIC_{15}	Nij	Chest g s	Chest Deflection
Pre-1998	Pass Rate %	5-6	100	*--	100	100
1998	Pass Rate %	9	100	100	100	100

* Nij data not collected by VRTC
Overall MY98 femur axial load Pass Rate was 100%.

Table A-14b
Pass Rate -MY99 vs Pre-MY98
48 kmph (30 mph), Unbelted Barrier, 50th Percentile Male Dummy
DRIVER

Model Year		n	HIC_{15}	Nij	Chest g s	Chest Deflection
Pre-1998	Pass Rate %	5-6	100	*--	100	100
1999	Pass Rate %	6	100	100	100	100

* Nij data not collected by VRTC.
** 1999 Acura 3.5 RL left femur axial load of 13,349 N exceeded the ICPL of 10,000N.
Overall MY99 driver-side femur axial load Pass Rate was 83.3% (5/6).

Table A-14c
Pass Rate - MY98 vs Pre-MY98
48 kmph (30 mph), Unbelted Barrier, 50th Percentile Male Dummy
PASSENGER

Model Year		**n**	**HIC_{15}**	**Nij**	**Chest g s**	**Chest Deflection**
Pre-1998	Pass Rate %	4-6	100	--*---	100	100
1998	Pass Rate %	5-6	100	100	88.9 **	100

* Nij data not collected by VRTC.
** 1998 Dodge Neon passenger-side had a chest g s of 61.4 g s.
Overall MY98 passenger-side femur axial load Pass Rate was 100%.

Table A-14d
Pass Rate - MY99 vs Pre-MY98
48 kmph (30 mph), Unbelted Barrier, 50th Percentile Male Dummy
PASSENGER

Model Year		**n**	**HIC_{15}**	**Nij**	**Chest g s**	**Chest Deflection**
Pre-1998	Pass Rate %	5-6	100	*---	100	100
1999	Pass Rate %	6	100	100	100	100

* (-----) missing Nij data needed from VRTC.
Overall MY99 passenger-side femur axial load Pass Rate was 100%.

Test Procedure Stringency Comparisons

Paired Dummy Responses (Same make/model): Tables A-15a & A-15b and Tables A-16a & A-16b compare the 50th percentile male and the 5th percentile female dummy responses, respectively, for the same test vehicle and same test condition.

Table A-15a
1999 Toyota Tacoma
Comparison of Responses by Dummy Size
40, 48, 56 kmph (25, 30, 35 mph) ODB Unbelted Tests
DRIVER

Delta V	Dummy Size	HIC_{15}	Chest g s	Chest Deflection	Nij	Failed Test
25 mph	50th 5th	96 238	42.8 50.5	46.1 40.5	0.339 0.615	no no
30 mph	50th 5th	176 199	43.7 52.3	48.35 51.41	0.333 0.481	no no
35 mph ODB	50th 5th	149 354	37.9 44.4	46.2 36.9	0.419 0.572	no no
ICPLs	50th 5th	700 700	60 60	63 52	1.0 1.0	

Table A-15b
1999 Toyota Tacoma
Comparison of Responses by Dummy Size
40, 48, 56 kmph (25, 30, 35 mph) ODB Unbelted Tests
PASSENGER

Delta V	Dummy Size	HIC_{15}	Chest g s	Chest Deflection	Nij	Failed Test
25 mph	50th 5th	82 143	23.45 34.1	15.7 3.7	**1.120** **2.064**	F F
30 mph	50th 5th	173 380	35.6 42.2	23.5 4.24	0.694 **2.65**	no F
35 mph ODB	50th 5th	208 163	39.4 41.73	23.4 1.14	0.567 0.609	no no
ICPLs	50th 5th	700 700	60 60	63 52	1.0 1.0	

Table A-16a
1999 Dodge Intrepid
Comparison of Responses by Dummy Size
40, 48, 56 kmph (25, 30, 35 mph) ODB Unbelted Tests
DRIVER

Delta V	**Dummy Size**	**HIC_{15}**	**Chest g s**	**Chest Deflection**	**Nij**	**Failed Test**
25 mph	50th 5th	193 99	40.1 40.52	33.0 32.05	0.407 0.349	no no
30 mph	50th 5th	403 139	54.4 56.6	44.8 **52.8**	0.522 **1.523**	no F
35 mph ODB	50th 5th	348 470	57.8 51.45	42.4 40.94	**1.39** **1.94**	F F
ICPLs	50th 5th	700 700	60 60	63 52	1.0 1.0	

Table A-16b
1999 Dodge Intrepid
Comparison of Responses by Dummy Size
40, 48, 56 kmph (25, 30, 35 mph) ODB Unbelted Tests
PASSENGER

Delta V	**Dummy Size**	**HIC_{15}**	**Chest g s**	**Chest Deflection**	**Nij**	**Failed Test**
25 mph	50th 5th	83 121	48.11 35.18	18.3 4.58	0.393 0.517	no no
30 mph	50th 5th	223 302	54.1 **62.12**	25.7 13.06	0.396 0.621	no F
35 mph ODB	50th 5th	196 366	53.2 **77.66**	19.5 12.3	0.574 **1.702**	no F
ICPLs	50th 5th	700 700	60 60	63 52	1.0 1.0	

1. The magnitude of the responses appear to be consistent between the two dummies for the same test condition.

2. There were 8 vehicles failures overall: 5 with Nij alone, 1 with Nij and chest g s, 1 Nij and chest deflection failure and 1 chest g s alone failure.

3. There were 4 cases where a test vehicle might pass with one of the dummies, but fail with the other one. The 5th percentile dummy appears to be more vulnerable than the 50th percentile dummy for the same test condition.

FMVSS 208 Full-Scale Barrier Tests vs Sled Tests, Average Response Values X Model Year.

Table A-17a
MY 1996-1998, 48 kmph (30 mph), Unbelted Full-Scale Barrier Test
50th Percentile Male Dummy

	HIC_{15}	**Nij**	**Chest g s**	**Chest Deflection**	**Left Femur**	**Right Femur**	**Sample n**
Driver							
96-98 MY	228	---	46.5	38.8	6012	6032	34
Pass Rate	100%	---	97%	100%	100%	100%	34
Passenger							
96-98 MY	246	---	46.4	19.5	5832	5883	34
Pass Rate	94%	---	91%	100%	100%	100%	34

For all vehicles 1996-1998, chest g s is the critical ICPL in the unbelted barrier test for both driver and passenger sides.

Table A-17b
MY 1996-1997, 48 kmph (30 mph), Unbelted, Full-Scale Barrier Test
50^{th} Percentile Male Dummy

	HIC_{15}	**Nij**	**Chest g s**	**Chest Deflection (mm)**	**Left Femur (N)**	**Right Femur (N)**	**Sample n**
Driver							
96-97 MY	232	---	46.72	39.37	6050	5963	28
Pass Rate	100%	---	96.4%	100%	100%	100%	28
Passenger							
96-97MY	252	---	45.93	20.68	5879	5955	28
Pass Rate	100%	---	92.86%	100%	100%	100%	28

For MY 1996-1997, chest g s is the critical ICPL for the driver and passenger-sides for the full-scale barrier test.

Table A-17c
MY 1998, 48 kmph (30 mph), Unbelted, Full-Scale Barrier Tests
50th Percentile Male Dummy

	HIC_{15}	Nij	Chest g s	Chest Deflection (mm)	Left Femur (N)	Right Femur (N)	Sample n
Driver							
1998 MY	209	0.390	45.2	36.3	5831	6353	6
Pass Rate	100%	100%	100%	100%	100%	100%	6
Passenger							
1998 MY	220	0.412	48.6	14.2	5616	5956	6
Pass Rate	100%	100%	83%	100%	100%	100%	6

For MY 98, passenger chest g s is still a problem in full-scale barrier tests. The 1 failure out of 6 was the Dodge Neon.

Table A-17d
MY 1998-99, 48 kmph (30 mph), Unbelted Sled Tests (S13)
50th Percentile Male Dummy

	HIC_{15}	Nij	Chest g s	Chest Deflection (mm)	Left Femur (N)	Right Femur (N)	Sample n
Driver							
98-99 MY	144	0.398	37.9	32.7	5283	5135	36
Pass Rate	100%	100%	100%	100%	100%	100%	36
Passenger							
98-99 MY	183	0.456	39.1	11.0	4832	4899	36
Pass Rate	100%	97%	100%	100%	100%	100%	36

For MY 98-99, there were 2 Nij failures passenger-side for the 208 sled test. Otherwise, there were wide margins of compliance for all other responses with 100% Pass Rates.

Table A-17e
MY 1998, 48 kmph (30mph), Unbelted Sled Tests (S13)
50th Percentile Male Dummy

	HIC_{15}	Nij	Chest g s	Chest Deflection (mm)	Left Femur (N)	Right Femur (N)	Sample n
Driver							
1998 MY	152	0.397	38.3	34.7	5231	5439	27
Pass Rate	100%	100%	100%	100%	100%	100%	27
Passenger							
1998 MY	184.9	0.436	39.37	12.58	4756	4811	27
Pass Rate	100%	96.29%	100%	100%	100%	100%	27

For MY98 alone, there was one Nij failure for the sled test. Otherwise, there were sufficient margins of compliance for all other responses with 100% Pass Rates.

Table A-17f
MY 1999 48 kmph (30 mph)Unbelted Sled Tests (S13)
50th Percentile Male Dummy

	HIC_{15}	Nij	Chest g s	Chest Deflection (mm)	Left Femur (N)	Right Femur (N)	Sample n
Driver							
1999 MY	116	0.402	37.22	27.0	5038	4763	9
Pass Rate	100%	100%	100%	100%	100%	100%	
Passenger							
1999 MY	176.7	0.515	38.22	6.17	5058	5165	9
Pass Rate	100%	100%	100%	100%	100%	100%	9

For MY99 there were no compliance test failures based on the sled. There was wide margins of compliance with 100% Pass Rates.

Table A-18a
MY 1998 Full-Scale 48 kmph (30 mph) Unbelted Barrier vs 208 Sled Test Comparison
50th Percentile Male Dummy

	HIC_{15}	**Nij**	**Chest g s**	**Chest Deflection (mm)**	**Left Femur (N)**	**Right Femur (N)**	**Sample n**
Driver							
1998 MY Full-Scale	209	0.390	45.2	36.3	5831	6353	6
1998 MY Sled	152	0.397	38.3	34.7	5231	5437	27
Passenger							
1998 MY Full-Scale	220	0.412	48.6	14.2	5616	5956	6
1998 MY Sled	184.9	0.436	39.37	12.58	4756	4811	27
ICPL 50th	700	1.0	60	63	10,000	10,000	

* All vehicles are used from the data file.

208 Sled vs 208 Barrier

FMVSS No. 208 Full-Scale Barrier Tests vs. Sled Tests, Average Response Values X Model Year, Unbelted 50th Percentile Dummy

These tables compare barrier and sled test results. Tables A-18b, A-18c and A-18d are the primary summary tables. Tables A-18b and A-18d show the sled is a less stringent test for all responses, except for Nij. Table A-18d shows an increasing trend for Nij by model year, whereas the other responses show a decreasing trend. For the MY98 matched pairs data set, all vehicles passing the sled also passed the barrier except the Dodge Neon. The 1998 Dodge Neon passed the sled chest g s by a wide margin, but failed the barrier chest g s by a slim margin (61 g s). Despite this one case, there were wide average margins of compliance (%) for both the sled and barrier at or below 80 percent as seen in Table A-18c. (Note: 80% is an arbitrary number used for analysis purposes.)

Table A-18b.
MATCHED: MY 1998 Make/Models: Full-Scale Barrier vs 208 Sled Test

	HIC_{15}	**Nij**	**Chest g s**	**Chest Deflection (mm)**	**Left Femur (N)**	**Right Femur (N)**	**Sample n**
Driver							
1998 MY Full-Scale	208	0.425	46.6	31.7	6234	6154	5
1998 MY Sled	107	0.357	34.17	26.22	5677	5965	6 *
Passenger							
1998 MY Full-Scale	199	0.418	48.4	12.9	5949	6227	5
1998 MY Sled	119	0.448	37.17	9.38	5138	5305	6 *
ICPL 50th	700	1.0	60	63	10,000	10,000	

* The sample with n=6 had two Grand Cherokee tests.
** We do not have any matched data sets (full-scale vs sled) for MY99.

Table A-18c
Average Percentage of ICPL (%) Comparison
MY 1998 Matched Make/Models: Full-Scale Barrier vs 208 Sled Test

	HIC_{15}	Nij	Chest g s	Chest Deflection (mm)	Left Femur (N)	Right Femur (N)	Sample n
Driver							
Sled	15.29%	35.7%	56.95%	41.62%	56.8%	60%	6 *
Barrier	29.71%	42.5%	77.7%	50.32%	62.3%	61.5%	5
Passenger							
Sled	17%	44.8%	62%	14.9%	51.38%	53.1%	6 *
Barrier	28.42%	41.8%	80.7%	20.5%	59.5%	62%	5

* n = 6 has two Grand Cherokees
** Dodge Neon passenger-side full-scale barrier Chest G s failure @ 61 g s.
*** NHTSA did not have any matched data sets (full-scale vs sled) for MY99.

1.) Tables A-18b and A-18d - In every case except Nij for MY98, the sled test appears to be less stringent than the full-scale test as expected, but both sets of data are well below the ICPL values. The higher Nij was only slightly higher, on the average. This held true for both matched make/models and unmatched make/models.

2. Table A-18d - With the exception of Nij, there is a trend toward lower responses by model year, for both driver and passenger, going from the barrier to the sled with pre-MY98 having the highest values. Nij increases from year-to-year.

Table A-18d
MY 1996-97 vs 1998 Full-Scale Unbelted Barrier vs 1998 & 1999 Sled

	HIC_{15}	**Nij**	**Chest G s**	**Chest Deflection (mm)**	**Left Femur (N)**	**Right Femur (N)**	**Sample n**
Driver							
1996-97 barrier	232	----	46.72	39.37	6050	5963	28
1998 barr 1998 sled 1999 sled	209 152 116	0.390 0.397 0.402	45.5 38.3 37.22	36.3 34.7 27.0	5831 5231 5038	6353 5439 4763	6 27 9
Passenger							
1996-97 barrier	252	----	45.93	20.68	5879	5955	28
1998 barr 1998 sled 1999 sled	220 184.9 176.7	0.412 0.436 0.515	48.5 39.37 38.22	14.2 12.58 6.17	5616 4756 5058	5544 4811 5165	6 27 9
ICPL 50th	700	1.0	60	63	10,000	10,000	

3.) The sled test (a less expensive test) could be used in the lab to predict full-scale results (a more expensive test). The Dodge Neon shows the sled is not a reliable predictor in every case.

4.) The Dodge Neon had a chest g s of 33 and 33 for the driver and passenger, respectively, on the sled, whereas for the barrier the Dodge Neon driver and passenger chest g s were 44 and 61. The Neon passed the 208 sled test, but failed the 208 barrier test. (NOTE: Model year 1998 vehicles were not designed using the 208 sled (S13) test procedure.)

5.) Some chest g s failures occurred with the full-scale barrier test, but none in the sled test.

Multi-Stage Inflators

A. **Two Stage Inflators**

The purpose of Table A-19 is to compare the magnitude of responses for Stage 1 vs Stages 1+2 for the same crash condition, or static OOP test condition, for several Hybrid III dummy sizes. This table contains several matched pair examples of Stage 1 vs Stage 1+2 inflation levels from which the difference in magnitude of the two inflation levels can be judged for a few specific make models. Stage 1 (only) improves Nij responses compared to Stage 1+2.

The Acura RL has a two stage inflator that can vary inflation force according to crash severity and Mercedes may introduce two stage inflator technology before MY99 is over. By the MY 2000, it is anticipated that BMW and Acura models will have dual threshold restraint systems (higher inflation threshold levels if the occupant is belted) with two stage inflator technology. MY 2000 Ford Taurus will have a dual threshold restraint system with two stage inflator technology. MY 2000 Toyota models are expected to employ 2 stage inflators and GM as well as Chrysler are expected to employ 2 stage inflator technology in MY 2001.[7]

[7] Source: IIHS Status Report, Volume 34, No. 4, April 24, 1999.

Table A-19
Dual Stage Inflator Comparison Stage 1 vs Stage 1+2
30mph Unbelted Barrier Crash Tests and Static OOP Position Tests

MY	MM	Test Date	HIC_{15}	Nij	Chest g s	Chest Deflect (mm)	Left Femur (N)	Right Femur (N)
Driver 50%-ile								
CONFIDE	NTIAL							
Driver 5th%F								
CONFIDE	NTIAL							
CONFIDE	NTIAL							
CONFIDE	NTIAL							
Pass 50th%M								
CONFIDE	NTIAL							
Pass 5th%F								
CONFIDE	NTIAL							
CONFIDE	NTIAL							
6-Year-Old Posit-ion 1								
1999	Acura RL	3960014 Stage 1+2	100	**1.16**	23.05	12.13		
1999	Acura RL	3960001 Stage 1	80	0.64	23.8	12.6		
1999	Acura RL	3960015 Stage 1 (repeat)	88	0.88	19.5	8.2		
6-Year-Old Posit-ion 2								
1999	Acura RL	3960016 Stage 1+2	113	0.809	19.2	9.53		
1999	Acura RL	3960002 Stage 1	101	0.733	17.76	3.02		

Bold Numbers indicate measured value exceeded proposed ICPL.

Test Procedure Repeatability

Table A-20
Test Procedure Repeatability
5th Percentile Female Dummy, Belted, 40 kmph (25 mph) ODB & 48 kmph (30 mph) FRB
(Transport Canada)

Test Speed	**Occupant Position**	**HIC_{15} %CV ***	**Nij %CV**	**Chest g s %CV**	**Chest Deflection %CV**	**Sample (n)**
25 Mph ODB (L)	Driver	+/-42.8%	+/-54.6%	+/-3.41%	+/-8.90%	3 - 1998 Cavalier
25 Mph ODB (L)	Passenger	+/-28.8%	+/-19.7%	+/-4.63%	+/-12.3%	3- 1998 Cavalier
30 Mph	Driver	+/-18.5%	+/-18.6%	+/-7.19%	+/-3.50%	3 - 1999 Cavalier
30 Mph	Passenger	+/-4.19%	+/-9.88%	+/-8.12%	+/-7.23%	3 -1999 Cavalier

The above data is to be released by Transport Canada by September, 1999.
* %CV = percent coefficient of variation = Standard Deviation (n-1) divided by the Mean X 100%. This is interpreted as +/- the value. ODB = 40% Offset Deformable Barrier Test, Left-side Impact.

In the NHTSA/Transport Canada cooperative research program two repeatability test series were conducted belted, in-position, for the 5th percentile female test dummy. For HIC_{15} and Nij, the 40 kmph (25 mph) ODB belted test had more variability than the 48 kmph (30 mph) full frontal barrier test. The 40 kmph (25 mph) ODB belted test using the 5th percentile dummy is proposed in the SNPRM. Table A-20 compares the variability of the ODB test to a 48 kmph (30 mph) full frontal barrier test. It is believed that the higher HIC_{15} and Nij variability in the ODB test is due to; (1) structural crush variability and (2) fire time variability. The 40 kmph (25 mph) ODB, 40% overlap, belted test procedure has been proposed specifically to help reduce fire time variability and enhance soft pulse crash sensing improving crash sensor and crash data processing algorithm design. The delay in inflator fire times due to the soft crash pulse is believed to cause out-of-position risk for occupants.

In prior agency analyses of test procedures (e.g., FMVSS 201, 214,), a %CV <= 5% is considered excellent and 5-10 % is considered good. It is known from prior crash test experience to expect a high HIC variability based on Gauthier/Machey 1981 Chevy X-body NCAP repeatability test series. The 40 kmph (25 mph) ODB test had a HIC_{15} variation range of about +/-29 to 43 percent and Nij variation range of +/-20 to 55 percent. The full frontal test, although at a higher speed, had a lower HIC_{15} variability range of +/-4 to +/-19 percent and an Nij variability range of +/-10 to +/-20 percent. The range of %CV values for chest acceleration (4-8%) and chest deflection (3-12%) are reasonable for both of these test procedures. It is important for the manufacturers to understand the variability of the proposed test procedures so they can set their design goals.

5th Percentile Female Dummy: Based on the subject belted ODB test data at 25 mph, the HIC_{15} and Nij are such that +/- 43 percent and +/-55 percent variability for HIC_{15} and Nij, respectively, on the driver-side may not easily be accommodated without some redesign. The passenger side HIC_{15} (+/-29%) and Nij (20%) variability may be more easily accommodated. Chest g s and chest deflection variability are not problems based on current vehicle designs.

At 30 mph belted barrier, high Nij variability would be a marginal problem on the driver-side, but not on the passenger-side using the 5th percentile female dummy. Chest g s, fortunately had much lower variability (+/- 4-8%) as average chest g s, both belted and unbelted are in the mid to high 40's. Chest deflections are sufficiently low in both belted and unbelted cases that variability is not an issue.

50th Percentile male Dummy: Assuming the 40 kmph (25 mph) ODB variability is the worse case scenario, it appears that the full-scale unbelted barrier data for MY 1998 and 1999 compliance margins would be sufficient to accommodate a 43 percent and 55 percent variability for HIC_{15} and Nij, respectively.

Table A-21
48 kmph (30 mph) Unbelted Barrier, 95th Percentile Male Dummy Responses
Driver and Passenger
(Confidential)

Table A-22
40 kmph (25 mph), Offset Deformable Barrier, Left Impact
Unbelted, 5th Percentile Dummy
(Confidential)

Table A-23
48 kmph (30 mph), 0 Degree, Fixed Rigid Barrier Test,
Unbelted, 50th Percentile Dummy
(Confidential)

Table A-24
Unbelted vs Belted
48 kmph (30 mph), 0 Degree Rigid Barrier, 50th Percentile Male Dummy
(Confidential)

Table A-25
Unbelted vs Belted
48 kmph (30 mph), 0 Degree Rigid Barrier, 50th Percentile Male Dummy
(Confidential)

Table A-26
40 kmph (25 mph), 30 Degree Oblique, Left Impact
Unbelted, 5th Percentile Dummy
(Confidential)